the wide inlets, where the currents are obviously swifter than along the open coast, the observed maximum velocities are only sufficient to move sand on the bottom by the formation and forward movement of sand ripples. A bottom velocity of about 2.4 ft. per sec. is necessary to destroy the sand ripples and move the sand in a continuous sheet.

Transportation of sand by currents with bottom velocities between 0.85 and 2.4 ft. per sec. takes place at a very slow rate. Experiments made by G. F. Deacon[1] showed that with a surface velocity of 1.5 ft. per sec. the velocity of motion of the sand was only $^1/_{2160}$ part of the surface velocity of the current, and at a surface velocity of 2 ft. per sec. the ratio was reduced to $^1/_{480}$.

Where there is a narrow inlet on the sandy beach and a large harbor or tidal reservoir, as is found in a number of places on the New Jersey coast, the tidal currents landward and seaward will have greater velocities near the entrance than at a wider entrance like New York harbor. In such cases the velocity of both flood and ebb is no doubt sufficient to move sand in a continuous sheet. As is well known, the transporting power of the ebb current through a narrow harbor inlet will exceed that of the flood owing to the gradient of the shore and the ebb being reinforced by land waters.

On the open coast the alongshore tidal currents oppose one another as transporting agencies, and owing to the gradient of the shore the tendency must be for material to move seaward.

There is little doubt that tidal currents along the open coasts of New Jersey and Long Island, unaccompanied by wave action and wind currents, have little direct effect in causing littoral drift, their chief effect being to transport material previously suspended or disturbed by wave action.

Littoral Drift Caused by Wind Currents

During gales wind-formed currents are created; and in tidal seas it is often difficult to separate the effects of such currents and tidal currents. In the author's opinion the effects of the wind-formed currents have been often underestimated. Many of the important shore features ascribed to tidal action by hydraulic engineers are produced on the shores of lakes and tideless seas by wind action alone. During gales alongshore wind-formed currents, especially when reinforced by tidal currents, have a powerful effect in causing the alongshore movement of sand and silt stirred up by breaking waves.

Littoral Drift Caused by Wave Action

Waves caused by an onshore wind which strikes the shore at right angles to the coastline do not themselves cause any alongshore movement of material, but owing to there being a surface current landward and a compensating undertow seaward, onshore winds cause the shore to be flattened out by dragging down material in a seaward direction. Waves which strike the shore at an oblique angle have, however, a very powerful influence in causing littoral drift. When an oblique wave breaks, the u. sh travels up the shore at an angle. The velocity may be considered as the resultant of two components—one at right angles to and one along the shore. When the oblique wave travels up the beach the velocity at right angles to the shore is gradually destroyed by gravity, while the other component is unaffected, except by friction, the result being that a particle of sand or shingle is carried up in a curved path and down again; the individual path of each particle being approximately parabolic, such as is described by a projectile thrown at an angle into the air. Hence oblique waves cause a travel of material alongshore. The more oblique the impact of the breakers is to the coastline, the more powerful is their effect in causing littoral drift. The power of oblique waves to transport material alongshore is also dependent on the strength of the wind and the fetch or distance of open sea across which the wind blows before reaching the coastline.

In considering the movement of material by wave action it is important to keep in mind that the transporting power of waves rapidly decreases as the depth of water and distance seaward of low water increase.

After carefully studying the conditions on the New Jersey and Long Island coasts, the conclusion arrived at is that as a general rule the littoral drift is mainly due to oblique wave action. It must be remembered, however, that during gales currents greatly assist the movement of sand and silt suspended or disturbed by breaking waves. During gales, when oblique waves were moving material in an opposite direction to the flood tidal current, the author has frequently, at high tide, found an alongshore wind-formed current seaward of the breaking waves, which measurements showed to have a surface velocity of from 0.5 to 1.0 ft. per sec. in opposition to the normal flood current.

During onshore gales, when the waves and wind-formed currents themselves have no direct effect in causing littoral drift, sand is frequently moved alongshore in the direction of the flood current. This is due to the fact that in some places the flood current commences to flow an hour or more after low water, while the ebb current does not commence to flow until an hour or more after high water. On such shores the upper part of the foreshore is only acted upon by the flood current, and sand disturbed by the onshore breakers would be suspended and carried some distance by the flood current before being deposited; but the ebb current, flowing at its strongest when the upper part of the shore was bared, would have no effect in bringing such particles of sand back again.

It is important to bear in mind that there may possibly be some local exceptions to the general rule here advanced, that oblique wind waves are the chief cause of littoral drift on the New Jersey and Long Island coasts. Before designing any coast-protection works it is necessary to examine carefully the local conditions in each case, in order to determine with certainty the relative effects of wind waves and tidal currents in causing littoral drift.

Littoral Drift Caused by Wind

At low tide oblique and onshore winds transport sand from the foreshore to the land. The chief effect is to erode the foreshore between the tide limits and build up above high-water mark sand dunes, which will themselves be moved inland in course of time, unless overgrown by vegetation. The erosion of the coast resulting from the formation and inland movement of sand will

[1] Minutes Proceedings, Institute of Civil Engineers, Vol. CXVIII.

be dealt with in the article on the causes of coast erosion.

If, as already stated, oblique wind waves are the chief cause of the littoral drift, then the direction of predominant drift should be in the direction of the prevalent or strongest waves causing the formation of such oblique waves.

Littoral Drift Off Long Island

Fig. 1 shows the action of oblique waves on the south coast of Long Island. It will be noticed that the shore is sheltered from the northeast winds, while the south and southeast winds, which strike the shore almost at right angles to the coast, will have little or no effect in causing littoral drift. The winds which will cause the formation of oblique waves are those coming from the east-northeast, east-southeast and southwest. Reference to the map will show that the section of shore from *A* to *B*, while sheltered from the southwest oblique waves, is exposed to those from the east-southeast and east-northeast, while the shore from *B* to *C* is exposed to oblique wind from the east-southeast, east-northeast and southwest. It is therefore reasonable to suppose that the predominant drift will be from *B* to *A* and that the drift between *B* and *C* will depend on the relative strength and duration of the winds causing oblique wave action in opposite directions.

While the northerly winds predominate on this coast, it will be noticed that the shore at the northeast end of Long Island is exposed to a greater range of winds capable of causing oblique wave and littoral drift in a northeasterly direction than to winds capable of causing littoral drift in a southwesterly direction. Moreover, the distance of fetch or open sea between New York harbor and the northern part of Long Island will enable the winds blowing from the west-southwest to cause oblique wind waves capable of effecting a certain amount of drift.

We may therefore expect that the direction of littoral drift will not be very clearly defined, but that near the northeast end of the Island it will probably be found to be from southwest to northeast.

A study of the local conditions shows there is abundant evidence that the predominant drift is from *B* to *A*. The spits and sand islands[2] in front of Fire Island, Jones and East Rockaway inlets have all moved in a westerly direction. According to the *Coast Pilot*, the spit in front of Fire Island inlet has for many years been moving westward at a fairly uniform rate. From this inlet to Coney Island the evidence of a predominant westerly drift is everywhere apparent. Between Fire Island inlet and the northeast end of the island the evidence of a predominant drift is not very clear. It appears that at Shinnecock Bay a spit may possibly have grown out from both sides of the bay, as the entrance is about in the center; but there is no conclusive evidence that this is so.

Littoral Drift Off New Jersey

Reference to Fig. 2 will show that from *B* (Bay Head) to *A* (Sandy Hook) the New Jersey shore is to some extent sheltered from oblique waves formed by northerly winds and exposed to oblique waves from the southeast and southeast; while the shore from Bay Head to Cape May) is exposed to oblique wave action caused by both northeast and southeast winds. As the northerly winds predominate, we may expect to find the littoral drift to be in a southerly direction from some point near Bay Head to Cape May and in a northerly direction from Bay Head to Sandy Hook.

A careful examination of the local conditions shows that this is so. Everywhere between Bay Head and Sandy Hook we find evidence of a predominant northerly drift.

A study of the reports of the U. S. Weather Bureau, shows that, between Long Branch and Sandy Hook, during the summer months, the prevalent oblique onshore winds are from a southerly direction causing a northerly movement of material. In the winter months northwest winds predominate and have little direct effect in causing littoral drift. Very severe winds from the east-northeast occur during the winter, but owing to the trend of the coast do not strike at a very oblique angle and cause a seaward movement of material. The amount of littoral drift taking place during such storms is insufficient to compensate for the drift caused by the prevalent southerly onshore waves.

Sandy Hook spit has gradually advanced toward the Long Island coast. A comparison of Keith's survey made in 1685 and the coast survey of 1885 shows that between these dates the northward advance has been about 4700 ft. Surveys made between 1836 and 1885 indicate that the spit sometimes increased in length and sometimes decreased, the net result being a northerly growth of about 300 ft. between the above-mentioned dates.

Formerly the Shrewsbury and Navesink Rivers had their outlets across the neck of the spit, but these have been dammed up by the littoral drift and the outlets for their waters driven northward along the land side of Sandy Hook.

The spit in front of Shark River has steadily worked northward until it has closed up the outlet; after a time a new outlet was formed further south during storms and floods or one has been artificially formed. In 1890 the outlet was closed by the northerly drift, and a new outlet was cut further south. This outlet immediately started to move northward, the movement being at the rate of about 20 ft. a day during a week when the outlet was under observation.[3] The spit in front of the Manasquan River outlet has also progressively moved northward until a new entrance has been formed to the southward by storms and floods, when the new entrance commenced to move northward again.

Everywhere between Bay Head and Sandy Hook we find evidence to prove that the predominant drift is in a northerly direction. South of Bay Head, on the contrary, we find conclusive evidence of the predominant drift being in a southerly direction.

Barnegat inlet moved southward about 2300 ft. between 1840 and 1874, the spit at the northside of the inlet advancing southward and erosion taking place on the south side, the width of the inlet remaining about the same.[4] Long Beach by its southern movement has

[2]The term "spit" is here used to designate the long sandy formations which have grown out across the inlets and locally termed "beaches." In places where the spit has been cut through and an island formed the term "sand island" is used.

[3]"Transactions," American Society of Civil Engineers, Vol. 23.

[4]Report of New Jersey State Geologist, 1905.

become joined to what was formerly Tuckers Island. In 1841 Little Egg inlet between Long Beach and Tuckers Island was about 7200 ft. wide; by 1885 the points of land had become joined together. Between 1772 and 1885 Five Mile Beach on the east shore of Cape May had moved southward about 3750 ft. At Great Egg harbor the "new inlet" which intersected the beach near Longport progressed to the southward until it joined the old inlet about the year 1859.[5]

Formation of Sand Spits and Sand Islands

The general tendency is for the sea to fill up the bays and plane down the headlands. Spits in front of bays and estuaries are formed where there is a predominant drift. If there is an abundant supply of littoral drift and an embayment in the coast, the sand is moved by wave action and currents in a more or less continuous manner, and instead of being moved back into the reëntrant angle is often built out in the form of a long spit. The action of oblique waves and currents is alone instrumental in building the spits or sand embankments which border the New Jersey coast up to the level of about low-water neap tides. After that level is reached the wind plays an important part in their formation. At low tide the onshore winds blow sand against the sea-constructed bank and wind-formed dunes are then brought into existence.

On the New Jersey coast the sand spits are mainly formed by littoral drift transported by oblique wave action, although assisted by currents. The formation of Sandy Hook has frequently been attributed primarily to tidal currents. In a report to the Coast Survey, 1856, it is stated that "it turns out that the growth of the Hook . . . goes on regularly and according to determinable laws. The amount of increase depends upon variable causes . . . and the cause of this is a remarkable northwardly current . . . along the shores of the Hook. For more than seven hours out of the twelve there is a northwardly current through the False Hook Channel. This northward current runs inside for eleven hours out of twelve. It is this conflict of these two northwardly currents outside and inside and the deposit of material which they carry to the point of the Hook which cause its growth."

As the cause of the littoral drift is a matter of considerable importance, the author has carefully looked into the latest available Government information about the tidal currents on this part of the coast. On the outside shore of Sandy Hook the flood and the ebb have practically the same velocity, while the ebb flows for a little longer time, and is in fact slightly more powerful, there being a general drift in a southerly direction amounting to about 7 mi. in 24 hr.[6] The flood and the ebb, therefore, oppose each other as transporting agencies. It is true that the upper part of the shore is only acted upon by the flood current, as the ebb commences to flow about one hour after high water; but from one hour before to one hour after high water the velocity of the flood current is very small, and it is doubtful if it is even sufficient to move sand by the slow forward movement of sand ripples. The maximum velocity of the flood current at the entrance channels to New York Bay is two hours before high water on the part of the shore, which is also acted upon by the ebb current. In the author's opinion it is physically impossible for Sandy Hook to have been formed primarily by the tidal currents, and that its formation is due to littoral drift caused by oblique wind waves and tidal and wind currents.

A spit built out across a bay may, in course of time, extend right across and form a lake behind it. Southward of Sandy Hook many bays which formerly indented the coast have been closed up by the formation of spits which have grown right across. Lakes have thus been formed at Elberon, Deal, Asbury Park, Ocean Grove, Ocean Park, Lake Como, Spring Lake and Seagirt.

Where a considerable quantity of land water drains into a bay or indentation, the land water may at times of flood break through the sand spit in one or more places. Where rivers discharge into bays the sea is often unable to maintain a continuous spit across, and during floods the river water may break through it in one or more places—long, narrow sand islands being thus formed. Spits in front of Shark and Manasquan River outlets have, as previously mentioned, been constantly breached and then built up again by littoral drift. History also shows that the Sandy Hook spit between Low Moor and its extremity has been broken through on several occasions, when the waters of Shrewsbury river would for a time empty directly into the sea.

On the Atlantic coast of America we frequently find a series of elongated sand islands more or less inclosing lagoons. In fact, such sand islands are more characteristically exhibited on the Eastern coast of the United States than on the coasts of other continents. These sand islands will often travel across the bay and join on to the coast, or the sand islands themselves may unite.

Where rivers discharge, the position for the entrance of the tidal waters and the exit for the river waters are in many places constantly changing; as while the sea is endeavoring to close the bay by a continuous sand embankment along which it can move fresh supplies of material, the land waters are trying to find an outlet. In many cases it is a continuous warfare, in which neither side is entirely successful.

Where there is an inlet or harbor having a narrow entrance, the flood current sets into the harbor, and during gales when the waves on the coast stir up material the current carries in suspension large quantities of silt and sand. At slack water this material is deposited in the harbor or inlet, especially where salt marsh plants have obtained a footing. This material is not picked up again by the ebb current, there being no wave action to stir up the material on the sheltered inlet, and consequently salt marshes form and increase in area. At and near the entrance to the inlet the ebb currents are more powerful than the flood currents owing to the gradient being seaward and to their being in many cases reinforced by land water.

The growth of a spit across an inlet by narrowing the entrance and increasing the size of the tidal reservoir increases the tidal scour at the entrance and may prevent the further growth of the spit alongshore, in which event an apposition form of spit is formed as at the extremity of Sandy Hook. The formation of salt marshes inside the harbor or under the shelter of the spit, on the other hand, tends to decrease the volume of tidal water, and consequently the scour.

[5] Report of New Jersey State Geologist, 1885.
[6] "United States Coast Pilot," Vols. IV and V.

Maintenance and Repair of Asphalt Block Pavements

By Edwin J. Morrison*

SYNOPSIS—Explicit directions for the repair and maintenance of asphalt-block pavements by an engineer of over 20-years' experience in the asphalt-block industry. Renovating old asphalt-block pavements by a surface treatment of asphaltic oil.

There are three principal things to be guarded against in the maintenance and repair of asphalt-block pavement: (1) Allowing small defects to go unrepaired until they grow into actual holes in the wearing surface; (2) making an incomplete, and therefore ineffectual, repair by simply "plugging the hole" and failing to make a repair of sufficient area to restore the surface of the pavement to its original grade and contour; (3) neglecting or failing to utilize the old blocks in a proper and effective manner.

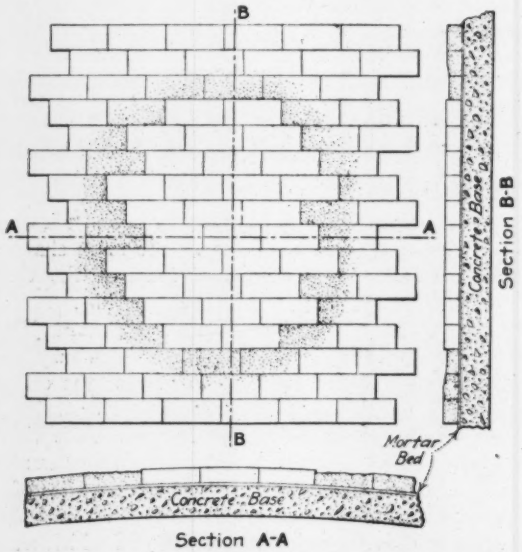

FIG. 1. WRONG WAY TO MAKE PATCHES IN ASPHALT-BLOCK PAVEMENT

Large numbers of old blocks, which properly relaid with asphalt-filled joints would have given good service for many years, have been thrown away; and in many cases where they have been used the relaying has been carelessly done and the joints filled with sand, leaving the blocks peculiarly susceptible to deterioration during winter weather.

The maintenance work, under the supervision of the writer, has averaged for a number of years somewhat over 1,000,000 sq.yd., and in speaking of the serviceability of the old blocks properly relaid and the economy resulting from careful attention to this feature of repair work he is speaking from a practical and well developed experience and not advancing a new or untried theory.

Blocks that are ten or more years old are generally hard and "dry" (the reason for which will be described later), and in taking up and relaying them the edges and corners are liable to be damaged. If the joints are simply filled with sand, the edges crumble under traffic, producing a rough and unsightly surface. The only proper method of treating the joints is by the use of an asphaltic filler. Where the joints are large or the edges and corners badly chipped, they should be filled with dry trap-rock grits before pouring the asphaltic filler. The joints should be made water-tight. The asphaltic filler is spread out by traffic, thus protecting the surface of the block as well as the joint.

The importance of treating the joints in this manner cannot be overstated. Such a repair results in a smooth surface, which under the action of traffic renders the patch indistinguishable in a very short time, whereas a patch made with the same blocks, with sand-filled joints, generally produces a rough surface with a percentage of bad joints which are subject to deterioration under traffic during the winter. The cost of applying the asphalt filler (which will be described later) is small and insignificant when balanced against the benefits accruing from it.

In making repairs to asphalt-block pavements the old blocks should be used to the utmost extent, and the new ones should be placed in continuous areas by themselves. The old blocks which are of the same formula, age and wearing quality will thus be brought together, and from the new blocks, laid by themselves, will be derived their utmost serviceability.

Contrary to much that has been written and said, the old blocks can be utilized to a very great extent in making repairs, if proper attention is paid to this point. Practically every whole block can be salvaged and efficiently used. This is true even where the blocks have one surface badly mutilated and are of unequal thickness, since the bad and irregular surface can be bedded in the mortar and the smooth surface of the blocks exposed to traffic.

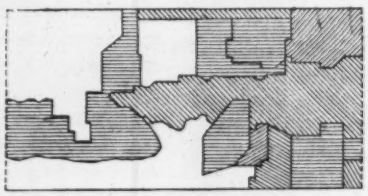

Fig. 2

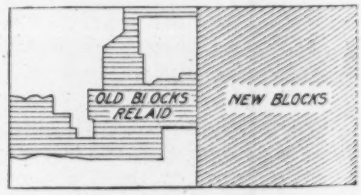

Fig. 3

FIG. 2. INEFFECTIVE PATCHES IN AN ASPHALT-BLOCK PAVEMENT

	Sq.Yd.	Per Cent.	Unit Price	Total Cost
Repaired with new block	129.6	64.8	1.60	$207.36
Original surface not repaired	70.4	35.2	....	.....
Totals	200.0	100.0	....	$207.36

FIG. 3. CORRECT METHOD OF REPAIRING AN ASPHALT-BLOCK PAVEMENT

	Sq.Yd.	Per Cent.	Unit Price	Total Cost
Continuous repairs with new blocks	93.3	46.65	1.60	$149.28
Repaired with old blocks	43.1	21.55	0.60	25.86
Original surface not repaired	63.6	31.80	....	.....
Totals	200.0	100.0	....	$175.14

*President of the Hastings Pavement Co., New York City. President of the Asphalt Block Pavement Co., Toledo, Ohio.

The sketch (Fig. 1) illustrates an incomplete repair, the unshaded surface representing new blocks and the shaded area showing old blocks left in their original position, slightly depressed. These should have been taken up and relaid, restoring the pavement to its original contour. Such an incomplete repair has generally resulted in unnecessarily rapid wear of the old blocks which are left in a slight depression around the original patch.

The sketch (Fig. 2) shows an actual condition on a street in the Borough of Manhattan, New York City, where the foundation was found to be very defective. The

FIG. 4. CONDITION OF OLD ASPHALT-BLOCK PAVEMENT BEFORE TREATMENT

hatched areas indicate a series of individual patches made during a period of about two years, resulting in a gross repair, aggregating 64.8 per cent. of the area shown, made entirely with new blocks. This made an irregular and unsatisfactory surface, because the individual repairs were of the kind indicated in Fig. 1.

Fig. 3 indicates what should have been done with this particular section of street. The hatched area marked "new blocks" contained many small depressions and defects. This area should have been taken up from curb to curb and repaved with new blocks to perfect line and grade in one operation. Of the old blocks removed there would have been more than enough of good quality to make the repairs in the area indicated as "old blocks relaid," and the result would have been satisfactory.

The method indicated by Fig. 2 resulted in an unnecessarily large use of new blocks, in no utilization of old blocks at all, and in a relatively unsatisfactory pavement surface; while the method indicated by Fig. 3, although requiring a much smaller expenditure of new blocks, would have placed them in one continuous area with perfect surface, utilizing at the same time a considerable percentage of old blocks, which in the other case were thrown away. The net result at prevailing unit prices for new blocks shows a saving in cost of over 15 per cent.

While a small section of pavement requiring unusually extensive repair has been taken for illustration, it serves very forcibly to indicate the ultimate, if not the immediate, economy of making a complete repair of defective conditions, thus saving and utilizing much old material instead of making a partial repair and allowing the small defects to go until they result in complete destruction of the surface.

The repair and treatment of asphalt blocks for maintenance purposes cannot be scientifically handled without some knowledge of the physical characteristics of the blocks themselves. This makes it important to review briefly the history of asphalt blocks and to show the general trend of the varying methods and formulas used during the past 20 yr.

Character of the Old Blocks

Asphalt blocks began to be used extensively in New York City about 1895. At that time, and for a period of about 10 yr., the asphaltic cement was prepared by fluxing refined "Trinidad" asphalt with from 6 to 8 per cent. of Pennsylvania or Ohio residuum oil, of 22 to 24 deg. gravity Bé. This resulted in a very hard cement, gradually growing harder with the lapse of years as the volatile matter in the flux oil evaporated. The hard blocks had a tendency to brittleness during the winter. In order to overcome this tendency a larger amount of heavier flux oil was used.

During the transition period which followed, the fluxing material was varied by using 9 per cent. of Ohio residuum oil of from 16 to 18 deg. Bé., 12 per cent. of 14 deg. Bé. oil and from 16 to 18 per cent. of 10 to 12 deg. Bé. asphaltic base oil. This process of evolution ended in the adoption, about 8 yr. ago, of a semiliquid flux derived from an asphalt—base oil, treated with air, steam or sulphur.

A fluxing material produced in this manner has all of the lighter volatile oils removed in the process of preparation and is very stable, being but slightly affected by temperature changes, and it does not liquefy under summer heat. These changes in the fluxing material, together with other changes in the kind and quantity of filler used and the grading of the mineral aggregate, have resulted in a gradual increase of bitumen in the block, accompanied by a gradual softening of the asphaltic cement, as indicated by the penetration.

We now know from the experience of later years that all the old blocks were not only too hard when they were made but have been gradually increasing in hardness

FIG. 5. PAVEMENT AFTER REPAIRS HAD BEEN MADE

ever since. This defect is cumulative in its effects, resulting in a chipping of the joints in winter and in the course of time in a pitting and scaling of the entire surface of the block; although otherwise these old blocks have, in a majority of cases, given excellent service.

Surface Treatment

The brittle condition of the old blocks led to the inauguration, some two or three years ago, of a series of experiments to determine a satisfactory and economical method

of surface treatment which would soften the hard asphaltic cement and prevent the chipping of the blocks in winter. These experiments embraced the use of a great many materials, applied in many different ways and under widely varying conditions. Complete success has been attained, and while a different treatment has to be applied to suit varying conditions of traffic and of the old blocks to be treated, the basic principle is substantially the same for all.

The method which experiment and experience have shown to produce the desired result is to dissolve a heavy bituminous oil in a volatile solvent and apply it to the

FIG. 6. RELAYING OLD BLOCKS IN GUTTERS

surface of the old blocks in the form of a thin wash or paint coat, giving one or more applications, as considered necessary. The solvent penetrates a considerable distance into the blocks and then evaporates, leaving a coating of heavy stable bitumen, which mixes perfectly with the old asphalt softening and giving it new life, while producing a malleable surface on the old blocks very similar to that produced by the formulas now used in the manufacture of new blocks.

After the application of the paint coat the entire surface of the pavement should be covered with a very thin layer of dry, fine trap-rock screenings, passing a ⅛-in. mesh screen; or any clean, dry sand will answer the purpose if trap rock is not available. The fine trap rock, sand and dust serve the double purpose of preventing the oil from being picked up by the shoes of pedestrians and tires of vehicles and, what is more important, cause the oil to be ground by traffic into the joints and inequalities of the surface. Where the joints are only slightly broken down this simple application is all that is needed to restore the surface of an old asphalt block pavement to a satisfactory condition. The cost of this surface treatment when applied to large areas will range from 2 to 4c. per sq.yd.

Brooklyn Example

Eighteenth St., from Sixth Ave. to Prospect Park West, covering an area of over 7000 sq.yd., was paved in 1906 with 3-in. asphalt blocks on a concrete foundation (by a company then just starting in the asphalt-block business). The materials and methods of manufacture were poor, and the condition of the surface of this street became so bad by 1914 that it was considered useless to make further repairs in the old way. It was admitted, however, that if the blocks could be saved and utilized by a surface treatment the value of the treatment would be fully demonstrated.

A contract was accordingly awarded in the summer of 1914, but on account of unexpected delay the actual work could not be started until Oct. 30, and it was not finished until Nov. 28, under somewhat unfavorable weather conditions. This work was done under the supervision of Herman H. Schmidt, Chief Engineer of the Bureau of Highways, by the Hastings Pavement Co.

The parts of the specifications covering the taking up, culling and relaying of old blocks and the special asphaltic filler for the treatment of joints follow:

The work shall consist of the removal of the present asphalt-block pavement and mortar bed; the repair of the present concrete foundation; the repaving of the roadway with asphalt blocks made up in part by new blocks and in part by old blocks taken from the present pavement, the treatment of the surface of the old blocks and all work incidental thereto, all in accordance with the plans and specifications on file in the Bureau of Highways, and over such areas as the engineer may direct.

The thickness of the mortar bed used under the culled blocks which are repaved over the above areas shall be approximately ½ in., but sufficient to bring the upper surface of the relaid blocks to an even grade with the adjacent pavement surface.

The asphalt blocks forming the present pavement, as taken from the street, shall be carefully culled and blocks which show a depth of 1½ in. or over and are otherwise suitable shall be piled separately and used for repaving.

The old asphalt blocks which can be used again shall be used to repave such areas as the engineer may direct. In addition the contractor shall furnish and lay, as directed by the engineer, new asphalt blocks, which shall conform in all particulars with the current asphalt block specifications of the Bureau of Highways, Borough of Brooklyn, which, so far as they apply, are made a part of this specification.

The surface of the present pavement which has not been disturbed, and those areas which have been repaved with blocks culled from the present pavement, shall be thoroughly broomed over with steel brooms and the joints cleaned and freed from all dirt and loose material.

Into the joints between the blocks shall be poured quartz gravel, crushed granite or trap rock, which shall be clean, approximately cubical, free from all foreign materials and

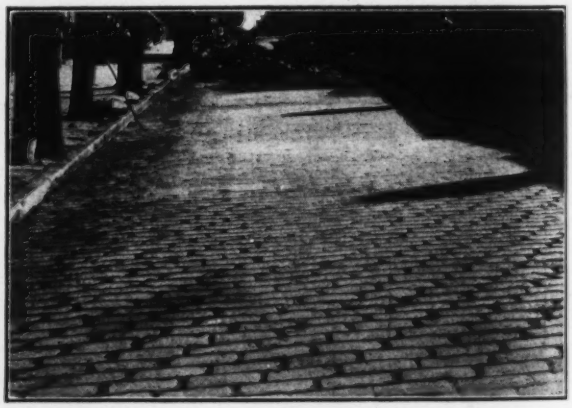

FIG. 7. JOINTS FILLED WITH ASPHALT AND GRITS

shall pass a ¼-in. mesh screen and be retained by a 20-mesh screen. It shall be artificially heated and dried in proper appliances placed near the work before being placed in the joints, if required by the engineer.

Immediately following the application of the gravel the joints shall be poured with an asphaltic cement conforming to the following requirements:

The block filler shall be a "blown" asphaltic oil product, or residual asphalt: (a) It shall contain not less than 99 per cent. of bitumen soluble in carbon bisulphide. (b) It shall contain not less than 98½ per cent. of total bitumen soluble in carbon tetrachoride. (c) It shall have a penetration at 77 deg. F. under a load of 100 grams for 5 sec. of not less than 55 nor more than 75. (d) It shall have a penetration at 32 deg.

F. under a load of 200 grams for 60 sec. of not less than 25. (e) It shall have a penetration at 115 deg. F. under a load of 50 grams for 5 sec. of not more than 200. (f) It shall have a ductility at 77 deg. F. of not less than 5 cm. nor more than 25 cm.

When these specifications were prepared it was expected that the work would be done in midsummer and that the treatment of the joints, as previously described, would be sufficient for their protection, and that the summer traffic would distribute the asphaltic filler over the surface of the blocks sufficiently to protect them against any tendency to pit or rough up during the succeeding winter.

This treatment would undoubtedly have been sufficient if the work had been done in midsummer, but as it was actually done in the cold weather of late November it was considered advisable to add to the treatment described

FIG. 8. PAINT COAT WITH SPRINKLING OF GRITS

in the specifications a surface treatment of the entire area of old blocks. This consisted of a paint coat composed of crude oil and a heavy asphaltic maltha of about 12 deg. gravity Bé., mixed half and half, applied hot and squeegeed over the surface, followed by a thorough sprinkling with fine trap-rock grits and dust passing a 20-mesh screen.

The result demonstrated fully the value of the treatment. The old blocks passed through last winter without exhibiting in the slightest degree any of the former tendency to break down at the joints or to pit on the surface.

The conditions on this street were peculiar in that certain sections and areas of the blocks showed very much more serious wear than others. These worst areas are fairly illustrated by Fig. 4. These areas were, of course, selected for taking up the old blocks from curb to curb, for the conditions were such that no amount of patching could produce a satisfactory surface.

On other parts of the street the general surface of the pavement was in very good condition and the original contour very well maintained, except for small defects here and there, particularly along the gutters. These portions of the street were repaired as shown in Fig. 5, by patching the defective places with old blocks reclaimed.

The sequence of operations is the relaying of the old blocks along the gutter (Fig. 6), spreading the trap-rock grits over the surface, filling joints with the trap-rock grits, the surplus being swept off; pouring of joints with the asphaltic filler, the surface treatment and application of the paint coat (Fig. 8), and finally covering with trap-rock grits (Fig. 7).

The area treated was 7184 sq.yd., of which 3022 sq.yd. was repaved with new blocks; 752 sq.yd. of old blocks were relaid and 3358 sq.yd. of old blocks were left in their original position, receiving only the joint and surface treatment. Thus 57 per cent. of the old blocks was reclaimed, a good average considering the very bad condition of this street. On other contracts of a similar nature the percentage of old blocks used has averaged between 80 and 95 per cent.

Eliminating Railway Grade Crossings in Los Angeles

A report on the elimination of railway grade crossings in the city of Los Angeles has recently been presented to the Municipal Board of Public Utilities by Franklin P. Howell, the board's Chief Engineer. Besides the elimination of grade crossings, Los Angeles has other problems which press for solution. Among these are the rerouting of its street-car service to reduce congestion and increase speed and the delays in the operation of interurban cars within the city.

The steam railway grade-crossing problem is easier of solution in Los Angeles than in many other cities because all the steam railways enter and leave Los Angeles in the valley of the Los Angeles River. The city's industrial district is located adjacent to the railways in this valley and generally on the same level as the railway tracks. It will not be feasible, therefore, to change the general level of these railway tracks, and Mr. Howell proposes that the principal thoroughfares crossing them and the industrial district through which the railways run should be carried by overhead viaducts. These should be wide enough to provide for the street-car traffic as well as the vehicle traffic, and would thus greatly relieve the present congestion and prevent delays which now result from street railways crossing steam railway tracks at grade.

Mr. Howell has made plans for six of these viaducts to have a minimum of 22-ft. clearance over the railway track and 14-ft. clearance over streets, increased to 15½-ft. clearance over street-railway lines. In the construction of such viaducts he proposes a two-column bent with spans of 40 to 50 ft. In crossing railroad yards, however, he advises longer spans to reduce the number of columns that would be endangered by derailed rolling stock. A span of 93 ft. would clear six tracks. For crossing the Los Angeles River he proposes a double-deck structure.

Special problems arise from the operation of the Pacific Electric Ry. Co.'s interurban system. This company's heavy interurban cars, weighing 35 to 40 tons and geared for high speed, are at present running from the outskirts of the city to its center on the city street railway tracks. These interurban cars add to the congestion on the street railway line, while the delay in reaching the heart of the city seriously affects the efficiency of the interurban service. Mr. Howell therefore recommends that the interurban lines should operate on a private right-of-way and should be required to elevate or depress their tracks above or below the street surface throughout the congested districts.

Engineering Literature

Heat Engineering

REVIEWED BY H. E. LONGWELL*

HEAT ENGINEERING: A Textbook of Applied Thermodynamics for Engineers and Students in Technical Schools—By Arthur M. Greene, Jr., Professor of Mechanical Engineering, Russell Sage Foundation, Rensselaer Polytechnic Institute; Sometime Junior Dean, School of Engineering, University of Missouri. New York and London: McGraw-Hill Book Co., Inc. Cloth; 6x9 in.; pp. xiv + 462; 198 illustrations. $4, net.

Should one dissect an average textbook treating of any specific type of heat engine, he will find that if the gossipy historical chapters, and the chapters on thermodynamic theory, and the chapters that deal with pure machine design, only, and the chapters that are written from commercial catalogs with the aid of a pair of scissors and a paste-brush, were all eliminated, an imposing volume will generally shrink to a comparatively insignificant book.

Since the same thermodynamic theory applies equally to steam engines, steam turbines, gas engines and compressors for air and other fluids; and since the same phenomena of heat transmission are common to boilers, condensers, evaporators, intercoolers, heating coils, refrigerating coils, cold-storage rooms, etc., it is evident that if a textbook has competent chapters on these general underlying principles, it is possible, on this common foundation, to present an adequate discussion of all the principal specific types of apparatus in a series of additional chapters so brief that they might almost be called appendices.

This is what Professor Greene has done. Emulating Doctor Eliot, who accomplished the prodigious task of crowding all the essentials of the world's literature on a bookshelf five feet long, he has succeeded in compressing a very respectable library of works on heat engineering to such a degree that it has ample elbow room on a bookshelf only one and one-half inches long.

The book opens with a most excellent and comprehensive chapter on thermodynamics, which the author characterizes all too modestly as "an outline only of the thermodynamic theory." This is followed by a short chapter (10 pages) on Heat Engines and Efficiencies, explaining the methods of reporting the performance, and giving a number of examples in which the efficiencies of various types of engines are computed from the observed data. With the addition of Chapter III on Heat Transmission we have a substantial foundation for the study of all the various engineering structures which involve the principles discussed in these three introductory chapters.

Chapter IV deals with Air Compressors; Chapters V and VI, with Steam Engines, simple and multiple expansion; Chapter VII, with Steam Nozzles, Injectors and Steam Turbines; Chapter VIII, with Condensers, Cooling Towers and Evaporators; Chapter IX, with Internal Combustion Engines, and Chapter X, with Refrigeration.

From this brief résumé of the contents, it will be seen that the work covers very broadly the entire field of heat engineering. This breadth of scope, however, is not, as one might suspect, obtained by superficiality. The author has selected and condensed his material with rare good judgment, and has left unsaid practically nothing that any reasonable reader would regard as essential to a complete exposition of the subject.

The author has wisely refrained from entering into the matter of the physical construction of the several machines discussed, a subject that pertains purely to machine design and which has no logical place in a work of this sort. One who can deal ably with thermodynamic theory is not apt to discourse in a particularly illuminating manner on bearings, cylinders, flywheels, governors and other mechanical details of machines, and when expert machine designers attempt to expound thermodynamic theory, they are often more amusing than instructive.

Naturally in a work of this sort mathematics is very much in evidence, but it is handled in an unusually lucid manner. The reader will not be confused by typographical errors in the mathematical expressions, and the many numerical examples worked out in detail make the meaning and application of the formulas readily understandable.

A complete table of the symbols used in the text and a comprehensive index finish off a well planned and admirably executed work.

In addition to being an excellent textbook for students, the practicing engineer will find it an efficient and convenient instrument for polishing up his memory in spots that may have become rusty.

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Machinists' Handbook Revised

REVIEWED BY ROSSITER R. POTTER*

AMERICAN MACHINISTS' HANDBOOK and Dictionary of Shop Terms: A Reference Book of Machine Shop and Drawing-Room Data, Methods and Definitions—By Fred H. Colvin, M. Am. Soc. M. E., Associate Editor of the "American Machinist"; author of "Machine Shop Arithmetic," "Machine Shop Calculations," "American Machinists' Grinding Book," "The Hill Kink Books," etc., and Frank A. Stanley, M. Am. Soc. M. E., Associate Editor of the "American Machinist"; author of "Accurate Tool Work," "Automatic Screw Machines," "American Machinists' Grinding Book," "The Hill Kink Books," etc. Second edition, thoroughly revised and enlarged. New York and London: McGraw-Hill Book Co. Leather; 4x7 in.; pp. xxvi + 673; numerous illustrations. $3.

During the seven years since the publication of the first edition this book has become very generally accepted as the standard handbook for machinists, machine-shop foremen and superintendents. The second edition shows an increase of more than 25 per cent. (160 pages). Nearly one-third of this increase is comprised in additions to the sections on milling and milling cutters, and on horsepower, belts and shafting. Of the twenty pages added to the latter section, the greater part presents in tabular form unusually complete data on the power requirements of various machine tools under different conditions. In the section on milling, ten pages of the new material cover the Cincinnati Milling Machine Co.'s experiments, which have led to the development of a new form of tooth for milling cutters. It is of interest to note that the results of these tests have also led the authors

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to reverse themselves in their explanation of the grade of finish obtained on milling-machine work. The major part of the new pages (chiefly tables) in this section is devoted to plain and differential indexing.

Some twenty-five pages are used to present six entirely new sections, as follows: Cold Saws; Turning and Boring; Oilstones and Their Uses; Broaches and Broaching; Steam Hammers and Drop Forgings; Knots, Eyebolts, Ropes and Chains. In the section on broaching, the S. A. E. standards are given for six and ten-splined holes. Many users of the book will wonder why the S. A. E. standards for square broached fittings were omitted. Other important additions are to the sections on Spiral Gears, eleven pages; Grinding and Lapping, twelve pages; Screw Machine Tools, six pages; Miscellaneous Tables, seven or eight pages, including dimensions and capacity tables for the leading types of modern ball bearings.

Noticeable effort has been made to improve the book in other ways besides the addition of new material. Most commendable perhaps of these improvements is the reduction to a more reasonable size of some of the simpler line cuts. The authors have succeeded in adding not a little to the convenience and value of the book. There is one careless error, in the use of an arithmetical sign, on p. 403, that has been carried over from the first edition. It is not a mistake that will be apt to cause much misunderstanding, but it sets a bad example to one class of users of the book and may diminish the respect of another class.

Engineering Economics

REVIEWED BY LEONARD METCALF*

ENGINEERING ECONOMICS; First Principles—By John Charles Lounsbury Fish, M. Am. Soc. C. E., Sometime Division Engineer Lake Shore & Michigan Southern Ry.; Professor of Railroad Engineering at Leland Stanford Junior University; author of "Earthwork Haul and Overhaul," etc. New York and London: McGraw-Hill Book Co., Inc. Cloth; 6x9 in.; pp. xii + 217; illustrated. $2, net.

The author states that his "book is intended to meet the first needs of the student and to render effective service in the office," and that it was written "in the belief that to the engineer a working knowledge of first principles is as essential in the economics as in the mechanics of structures; and that special study and drill in the application of principles is as advantageous in the one case as in the other." The object of the author is a worthy one and the book gives evidence of careful study and thought.

The treatment appears to the reviewer didactic and unfortunate. A simple and more direct approach, reasoning from well-selected examples to principles, would seem likely to be more interesting to the student and to give point to the individual character of most economic engineering problems. Completeness of treatment in such problems is rarely to be obtained in practice, and the most reliable estimator is the one who has the keenest sense of the important elements in his problem, coupled with the most direct and simplest methods of approach to and solution of it. While it is desirable that the student should be instructed in the general methods of analysis and application of formulas, it is of far greater importance that he should develop a sense of perspective, be shown how to grasp the really important elements of his problem, and then work out in the simplest manner his analysis or formula indicating the influence of the various factors.

One of the greatest dangers in much of the cost estimating or valuation being done today lies in the failure to grasp and weigh the relative importance of the various factors involved, including hazard and the human problem, and in the failure to make proper allowance for the different conditions surrounding the different works, cost records of which have been obtained, and to compare the sum of the assembled individual cost sheets of different branches of the work with the final actual cost of the entire work. It is the failure to do this that has brought the estimates of so many engineers into disrepute, as unreliable in the opinion of bankers, owners and builders of such works. The author's failure to emphasize this side of the subject is unfortunate, as is the purely mathematical rather than constructive method of treatment adopted by him.

After a brief introduction, the elements of the problem of economic selection are treated, including simple and compound interest, sinking funds and annuities, first cost, and salvage value. In discussing the latter the term depreciation is given a significance totally at variance with accepted practice—depreciated value being defined as salvage value. Elements of yearly cost of service, amortization, interest and other fixed charges, operation, maintenance and outstanding data are then discussed. Next estimating is taken up. This includes general practice, effect of laws of error, and quantities of some particular types.

The solution of the problem of economic selection is then treated under four bases: Yearly cost of service, the capitalized cost of service, cost per unit of service, and capitalized cost per unit of service, per year. This is followed by methods of procedure for economic selection, with examples.

A fair bibliography, depreciation and life tables, and tables of formulas follow.

The book is disappointing from the point of view of the practicing engineer and might advantageously be simplified from that of the student, as it tends to bring into undue prominence formulas rather than methods and the relative importance of the elements of the problem.

AN INTRODUCTION TO TOWN PLANNING: A Handbook Dealing with the Principles of the Subject and a Consideration of the Problems Involved, Powers of Local Authorities, etc.—By Julian Julian, Borough Surveyor, Cambridge. London: Charles Griffin & Co., Ltd. Philadelphia: J. B. Lippincott Co. Cloth; 5x8 in.; pp. vi + 149; illustrated. $1.75, net.

In contrast with most of the other books on town or city planning, this volume is small, handy, and contains but few illustrations—all line cuts.

After a brief but interesting review of the history of town planning the author takes up the powers of local authorities under the earlier by-laws and the 1909 Town Planning Act. He then considers some of the practical details of the preparation of town plans and passes on to "A Town Planning Tour," which consists of brief notes on salient features of the plans of a number of British and Continental cities. Appendixes deal with garden cities and suburbs, examples under the Town Planning Act of 1909, and extracts from Congressional resolutions, from the procedure schedule of the Town Planning Act and from a few books and papers on town planning.

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As may be inferred, most of the space is devoted to British practice, which is exactly what many people this side the Atlantic would like to know about. The other matter in the book, however, is perhaps of more interest to Americans generally. The book is readable.

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A Contractors' Textbook

THE ECONOMICS OF CONTRACTING: A Treatise for Contractors, Engineers, Manufacturers, Superintendents and Foremen Engaged in Engineering Contracting Work; Vol. II.—By Daniel J. Hauer, Construction Economist; Editor of "The Contractor." Chicago (Rand McNally Building): E. H. Baumgartner. Cloth; 6x9 in.; pp. 334; 27 illustrations. $2.50.

The earlier volume of this two-volume work (reviewed in *Engineering News*, Feb. 15, 1912, p. 325) laid down the principle that contracting had now become a profession and as such could be successfully discussed in a textbook. As was pointed out in the review of that first volume, however, contracting is primarily a business and one of the most complicated businesses in the world. Its principles, therefore, may be broadly outlined in any textbook, but the essentials of its practice are hardly reducible to words. In so far as it is possible to make such reduction, Mr. Hauer has succeeded admirably, but the fact remains that his two volumes are for the most part interesting and instructive reading for the present or prospective contractor rather than a *vade mecum* or handbook without which his business would suffer.

The second volume seems to have been conceived after the first was written, for there are many duplications of thought and hardly any strict differentiation of subject matter in the two volumes. This does not prevent the second part from having much that is new and interesting, because the subject is so broad that complete treatment could not be expected in one volume. The chapter headings of Volume II are as follows: Estimating and Bidding upon Contracts; Making Contracts and Obtaining Bonds; Financial End of Contracting; Preventing Law Suits; Planning Construction Jobs; Handling and Training Men; Office Filing Systems; Organization of a Construction Company; Lines of Contracting and Specialization and the Standing of Contractors. Generalizing broadly, it might be said that the chapters on office systems and financial organization will prove the most valuable part of the book and the sections devoted to the handling of men will be read with the most interest. Those chapters which attempt to outline methods of work could well have been omitted.

⌘

English Surveyors' Handbook

SURVEYING AND BUILDING CONSTRUCTION for Agricultural Students, Land Agents and Farmers—By A. H. Haines, Head of the Estate Management Department and Lecturer in Surveying at the South Eastern Agricultural College, Wye, Kent, England; Member of the Board of Studies in Agriculture of London University, and A. F. Hood Daniel, Lecturer in Building Construction at the South Eastern Agricultural College. New York and London: Longmans, Green & Co. Cloth; 6x9 in.; pp. xiii + 339; 222 illustrations. $3, net.

A typically English book. It combines subjects which are never associated in a single textbook in this country, and it contains many terms wholly unfamiliar to American engineers. Judging by the text, the work of an English surveyor includes farm building construction and a variety of things under farm management and the handling of estates which have never been grouped into a distinct profession on this side of the water.

The text is both elementary and practical. The first chapter on mensuration includes much elementary matter, tables, etc., usually to be had in our engineering pocketbooks. Rules are given for ascertaining the contents of ash heaps, the weight of cattle, the contents of dung heaps, of haystacks, cornstacks, etc.—information of a character which is rarely if ever found in American books.

It would seem that Gunter's chain (invented by Edmund Gunter in 1620) is still universally used for rural surveys. The steel tape, now so exclusively used for all survey work in this country, is in England used for land surveys "when very accurate measurements are required." Acres there are still divided into roods and perches.

Surveying equipment consists of ranging rods, poles, pickets, pegs or false pickets, offset poles, etc. Even the standard field notebook is different from ours, being 8 in. long by 4½ in. wide and opening on the end instead of on the side. The notes are not kept in the same manner either; the traverse is generally represented by a double line with station distances written between. Instrument station distances are inclosed in rings.

Surveying instruments, to judge from the illustrations, are of the type which was used in this country about 1850; at least some similar illustrations of levels and theodolites may be found in a Pike's catalog of surveying instruments published in New York in the fifties. These include a theodolite with high standards, with the vertical arc between the standards, such as few engineers in this country are old enough to remember having seen in use.

Under building construction is the usual collection of material on brick laying and masonry, carpentry and joinery, to be found in many of our American handbooks. There are a short chapter on hygiene (of the farm) and several pages of regulations of the local government board on dairy sanitation, farm water-supplies, drainage, etc. There is probably much of interest to American agricultural students in these parts of the book, although, as we have endeavored to show, there is little in the chapters on surveying that is common to American practice.

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Tree and Shrub Field Book

FIELD BOOK OF AMERICAN TREES AND SHRUBS: A Concise Description of the Character and Color of Species Common Throughout the United States. Together with Maps Showing Their General Distribution—By F. Schuyler Mathews, author of "Field Book of American Wild Flowers," "Field Book of Wild Birds and Their Music," "Familiar Life of Field and Forest," Familiar Features of the Roadside." New York and London: G. P. Putnam's Sons. Cloth; 4x7 in.; pp. xvii + 465; profusely illustrated. $2, net.

Those who wish a small book to aid in the identification of the trees and shrubs of North America and to give some general information regarding their physical characteristics, industrial uses and geographical range will find this volume both useful and handy. The author states that he has given particular attention to the esthetic side of his subject, including color, form and proportion, and to scientific accuracy, particularly in his descriptive nomenclature.

The plan of the book is to give a general description of the tree or shrub under consideration, particulars of its bark, branching system, foliage, flowers and fruit, and then to state its geographical range and the character and value of its wood for timber purposes (if a tree). Pen sketches of two-thirds natural size show the leaves, flower and fruit of many of the trees and shrubs described in the text, and water-color and crayon sketches give general im-

pressions of the looks of typical specimen trees. Detail views of the bark of 18 trees serve as a key for the identification of trees by their bark. By similar ingenuity the distribution of trees and shrubs throughout the United States is shown by a series of 70 maps. Beneath each map are page references to the description of the several trees, the location of which is shown by it. A few other maps and diagrams add to the value and interest of the book. An index by common and botanical names completes the volume.

Electrical Engineers' Handbook

AMERICAN HANDBOOK FOR ELECTRICAL ENGINEERS: A Reference Book for Practicing Engineers and Students of Engineering—Compiled by a Staff of Specialists, Harold Pender, Editor-in-Chief; Professor of Electrical Engineering, University of Pennsylvania; formerly Director of Electrical Engineering Research Laboratory, Massachusetts Institute of Technology. New York: John Wiley & Sons, Inc. London: Chapman & Hall. Flexible leather; 4x7 in.; pp. xviii + 2023; illustrated. $5, net.

With at least two good handbooks for electrical engineers available, this one may be expected to show, and it does show, every evidence of careful and deliberate editing.

To many engineers, especially those dealing with the more practical application of electricity and electrical machinery, this volume will make a stronger appeal than some earlier ones because of the wide separation of theoretical discussion and practical description and the arrangement of relatively short notes in alphabetical order. To other engineers, particularly designers, the absence of logical grouping for sequence may prove disconcerting.

With the present arrangement a very good index is essential, since few persons would make the same alphabetical distribution of topics. A high degree of excellence has been secured in the index, though there still remain a few tortuous paths before some seekers will locate the information which they desire. For instance, one trail leads to "shunt wound—see name of apparatus," "dynamos—see generators and motors," and "generators, direct-current . . . . field winding, 671 . . . .," etc., before the reader rounds up the several items which may cover "shunt-wound dynamos." This may possibly be excused by the claim that no self-respecting electrical engineer would ever refer to "dynamos."

The scope of the handbook is very broad indeed, giving as it does—in addition to the principles and phenomena of electricity and magnetism, to all sorts of electrical instruments, apparatus, service equipment, practices and methods, and to closely related non-electrical matters—approximately 350 pages, or 18 per cent. of the whole text, on non-electrical matters of not very close relation. Such topics include the economic ideas of depreciation, interest and annuities; notes on general materials like timber, brick and concrete masonry, irons and steels, fuels, gases, acids and explosives, and also notes on mechanics and common machinery, simple structures, steam engineering and thermodynamics, hydraulics, dam construction, and waterwheels.

The book is so comprehensive in its purely electrical features that a detailed summary and criticism of its contents cannot here be attempted. It must suffice to state that a careful examination, coupled with a few weeks of desk reference, gives every indication of a comprehensive but concise treatment reasonably responding to a variety of demands for information. The general inclusion of cost data and a bibliography for each topic is sure to merit approval, even though the cost figures can give only a general idea of expense and the bibliographies reflect some personal preferences and lapses.

Study of a few sections will show the typical treatment of electrical subjects to be found throughout the book.

For instance, the chapter on "Primary Batteries" briefly but effectively passes over fields of service, theory of action and features of typical cells in five pages, while four pages are devoted to dry cells, their life, service, capacity, testing and cost (dry batteries have become of surprisingly great commercial importance).

"Storage Batteries" illustrates a more extended treatment of a subject. The theory and design of the alkaline (Edison) type are given in 2½ pages; performance features require about four pages; testing, one page; dimensions, weight, cost, etc., 1½ pages. The lead type of storage battery is similarly discussed in 17 pages. Applications of storage batteries in general are given in 16 pages.

The distribution of the component parts of a broad subject is well shown by "Electric Lighting." This is taken up under the separate topics of electric arc, arc lamps, incandescent lamps, distribution and transmission systems, laws of vision, laws of illumination, photometry, photometric quantities, street illumination and interior illumination. Under "Arcs" are brief notes on current through metallic-vapor streams, temperatures, luminosity, voltage-current relations, musical arcs, high-frequency oscillations caused by arcs, etc. Under "Arc Lamps" are such subtopics as voltage drops, increasing luminosity, commercial open and inclosed arcs (with tabulated performance data), flaming and magnetite arcs, regulating mechanisms, mercury-vapor lamps, and first and annual costs. Under "Incandescent Lamps" are short descriptions of incandescence phenomena, commercial carbon- and metal-filament types, typical performance data (which are already somewhat incomplete due to six months' advance in the development of certain tungsten lamps), cost of light, reflectors, etc. Under "Distribution and Transmission Systems" are found fairly complete notes on constant-current and constant-potential lines, direct and alternating systems, typical city circuits, efficiency, regulation, load balance, etc. "Laws of Illumination" covers the fundamental "inverse-square" and "cosine" laws for the propagation of light and illumination calculations. "Interior Illumination" describes direct, indirect and semi-indirect disposition of illuminants, quantity of light required for various arrangements, best location of lamps and maintenance. "Street Illumination" gives the requirements of various streets, types of lamps available, desirable spacings and suspension heights, and costs. Under "Photometry" is presented a review of laboratory practice in measuring candlepower and flux-distribution characteristics of illuminants. "Photometric Quantities" defines the terms involved. "Laws of Vision" includes a summary of the rod-cone theory, and of intensity, extensity, color and duration sensations. It summarizes data on amount of light flux needed for best vision.

ZEITSCHRIFTENSCHAU AUS DEM GEBIETE DES WASSERBAUES, Heft 1: Im Auftrage des Ministerium der öffentlichen Arbeiten—Herausgegeben von Wilhelm Ernst & Sohn, Berlin, Germany. Paper; 11x14 in. Yearly price, 12 Marks.

An index, with abstracts, covering periodical literature in the field of hydraulic construction is something

new in the publishing world. This is its first issue, Heft I. We are not informed how often it is to appear, but the price of annual subscription is stated. The scheme of grouping is to place all the matter under about 110 heads. In each issue all the abstracts under "Sewerage," for example, are placed together, and occupy one or more quarter-page units, each headed by the words "Entwasserung von Städten (siehe auch Abwasser.)"

The arrangement is designed for clipping and filing. Each page is ruled into quarters $4\frac{7}{8}$x$6\frac{1}{8}$ in., treated as units which may be clipped out and filed in a card file of corresponding size. The paper is heavy, for this purpose, and the printing is on only one side.

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BUILDING THE NEW RAPID-TRANSIT SYSTEM OF NEW YORK CITY—By Fred Lavis. From Personal Studies for "Engineering News," with Use of Official Data and Photographs of the Public Service Commission. (Containing also Design of the New Elevated-Railway Lines by Maurice E. Griest, Assistant Designing Engineer, Public Service Commission for the First District.) [Reprinted from "Engineering News."] New York and London: McGraw-Hill Book Co., Inc. Cloth; 9x12 in.; pp. 73; 99 illustrations. $1.50.

In presenting this collection of carefully prepared matter the publishers perform a creditable service in making generally available a comprehensive study of subway-building methods. Fred Lavis' observations of the way different contractors on the New York subways are handling their work are no doubt the better for being based on years of experience in construction. This is fortunate in view of the fact that no summary of the construction methods has been published by the Public Service Commission or by other competent source. Probably it will be some years before any such summary will be issued, if at all. Until then Lavis' account is the only thorough collection of data available.

Special mention is due M. E. Griest's complete statement of how the New York elevated-railway lines were designed. First-class structural-steel practice is represented in these lines, and careful analysis and reasoning were employed in fixing the details. Mr. Griest's monograph is a classic of the subject.

⁂

BUILDING CODE RECOMMENDED BY THE NATIONAL BOARD OF FIRE UNDEDWRITERS, NEW YORK: An Ordinance Providing for Fire Limits, and Regulations Governing the Construction, Alteration, Equipment, Repair, or Removal of Buildings or Structures. Fourth Edition, Revised. New York (76 William St.): National Board of Fire Underwriters. Linen; 5x8 in.; pp. 326; illustrations.

Nominally this is a revision (4th edition) of the "model" building code first prepared by the National Board of Fire Underwriters in 1905. In reality it is a completely new building code and may be described as one of the most progressive documents in this field which has come out in recent times. The structural and fire-protection elements of the code have been revised throughout. The question of incombustible roofings is treated quite carefully, and a test for degree of inflammability is given. Just as radical are the requirements for certificates of occupancy for buildings; for certain occupancies sprinklers are required. Drastic new provisions are made for fire escapes; ordinary iron balconies connected by ladders or steps are not regarded as fire escapes except under special circumstances. In general, horizontal exits, smokeproof towers and outside stairways are called for. Exits are proportioned according to the number of occupants instead of floor areas. The new Forest Service grading rules for timber are included, and load tables for timber beams are given, based on considerably higher fiber stresses than heretofore used, namely, 1600 and 1200 lb. per sq.in. for yellow pine of grades 1 and 2, 1200 lb. for Douglas fir, 1000 lb. for spruce or Norway pine, 1300 lb. for western hemlock, and 1400 lb. for oak.

The inclusion of full specifications for the use of hollow blocks in walls, without discrimination, may also be considered a progressive requirement.

Every one concerned with the administration, preparation or improvement of building codes needs the book, and all who contemplate building a house should study its provisions.

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A useful classified reference list of books and articles on city planning has just been published by the Public Library, Riverside, Calif.

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A pamphlet of rules and instructions for the guidance of applicants for the approval of plans for the repair, alteration and construction of dams has been prepared by the engineering department of the Water Supply Commission of Pennsylvania (Harrisburg). Specimen plans are shown.

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A bulletin on "The Regulation of the Jitney Bus," by Andrew Linn Bostwick, Librarian, Municipal Reference Branch, has been issued by the St. Louis Public Library. It contains a useful digest of the municipal ordinances which have been enacted in some twenty-five cities of the United States where jitney busses have been extensively used.

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A complete account of the construction of the new mechanical filtration plant at St. Louis, Mo., the largest of its type in the world, is contained in the Annual Report of the Water Commissioner of St. Louis for 1914-15, just received. The report contains much matter descriptive of the St. Louis water-works not generally found in a publication of this kind. There is also a bibliography of all publications, articles, etc., on the water-works from 1865 to 1914. A supplemental report on water-supply by Edward E. Wall, Water Commissioner, covers in detail the improvements authorized in 1912 and now practically completed, including the filter plant, which was described by Mr. Wall in *Engineering News* of Oct. 23, 1913. Other features of the new construction have also been described in the issues of Dec. 25, 1913, May 14, 1914, and Jan. 28, 1915.

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There are now available for distribution the standard specifications adopted by the American Society of Municipal Improvements at Boston in 1914 for Sheet Asphalt Paving, Brick Paving, Creosoted Wood-Block Paving, Stone-Block Paving, Cement Concrete Paving, Broken Stone and Gravel Roads and Sewer Construction. The specifications for Bituminous Paving are not yet issued, but are kept waiting for a report of the committee on bituminous paving. George W. Tillson, Consulting Engineer of the Borough of Brooklyn, New York City, is Chairman of General Committee on Standard Specifications. The specifications are copyrighted but any municipality will be given the right to use them or any part of them upon application to the secretary of the society. The

separate specifications in pamphlet form are 25c. each and the complete set of eight may be had in a bound volume for $2. They may be obtained of Charles C. Brown, Secretary of the American Society of Municipal Improvements, 702 Wulsin Building, Indianapolis, Ind.

NEW PUBLICATIONS

[So far as possible the name of each publisher of books or pamphlets listed in these columns is given in each entry. If the book or pamphlet is for sale and the price is known by the editor, the price is stated in each entry. Where no price is given it does not necessarily follow that the book or pamphlet can be obtained without cost. Many, but not all, of the pamphlets, however, can be secured without cost, at least by inclosing postage. Persons who are in doubt as to the means to be pursued to obtain copies of the publications listed in these columns should apply for information to the stated publisher, or in case of books or papers privately printed, then to the author or other person indicated in the notice.]

GARDNER AIR-LIFT PUMPING: Condensed Suggestions for the Installation of an Air-Lift System of Water Pumping —Some Tables of Efficiency, also Some Descriptive Data of Various Standard Types of Gardner Air Compressors. Quincy, Ill.: The Gardner Governor Co. Paper; 6x9 in.; pp. 16.

A catalog which, besides describing the compressors of this manufacturing company, gives a very interesting and complete discussion of air-lift pumping. It describes several ways of piping the well for air lift and reviews the advantages of the system. One table gives pressure and amount of air required to raise water, and another one, the horsepower required to compress air.

THE COLORADO STATUTE INCH AND SOME MINER'S INCH MEASURING DEVICES—By V. M. Cone. Bulletin No. 207, based on the work done in the hydraulic laboratory at Fort Collins, Colorado, under a cooperative agreement between the Colorado Experiment Station and the Office of the Experiment Stations, United States Department of Agriculture. Fort Collins, Colo.: Colorado Experiment Station. Paper; 6x9 in.; pp. 16; illustrated.

FORESTRY IN RELATION TO CITY BUILDING: An Address by T. P. Lukens. Throop College Bulletin, July, 1915. Pasadena, Calif.: Throop College of Technology. Paper; 6x8 in.; pp. 34; illustrated.

The author urges reforestation and also fire control in forested areas. He states that the yield of the collecting area of the Pasadena water-supply has doubled since 1899 and attributes it to the absence of fires in that area—the last large fire having occurred in 1895, when at least 12 of the 20 sq.mi. of drainage area was burned over.

GUIDEBOOK OF THE WESTERN UNITED STATES—Washington, D. C.: Superintendent of Documents. Paper; 6x9 in.; illustrated.

Part A—The Northern Pacific Route, with a Side Trip to Yellowstone Park—By Marius R. Campbell and Others. Bulletin 611.

Part B—The Overland Route, with a Side Trip to Yellowstone Park—By Willis T. Lee, Ralph W. Stone, Hoyt S. Gale and Others. Bulletin 612.

Two other of these interesting and useful guidebooks will be published, covering the Santa Fé route and the Shasta route and Coast Line. Owing to the possible large demand and the limited number of copies available, those wishing the guidebooks must obtain them from the Superintendent of Public Documents, price $1 each.

WATER PURIFICATION PLANTS AND THEIR OPERATION —By Milton F. Stein, Assoc. M. Am. Soc. C. E., Assistant Engineer, Cleveland Filtration Plant. New York: John Wiley & Sons, Inc. London: Chapman & Hall, Ltd. Cloth; 6x9 in.; pp. viii + 258; 95 illustrations, 11 charts. $2.50, net.

HISTORY OF THE PANAMA CANAL: Its Construction and Builders—By Ira E. Bennett. Associate Editors: John Hays Hammond, Patrick J. Lennox, B. A., Litt. D., William Joseph Showalter, Capt. Philip Andrews, U. S. N., Rupert Blue, M. D., D. P. H., J. Hampton Moore. Builders' Edition. Washington, D. C.: Historical Publishing Co. Cloth; 7x11 in.; pp. 583; illustrated. $5.

INTERNATIONAL ASSOCIATION FOR THE PREVENTION OF SMOKE: Proceedings of Annual Convention Held at Grand Rapids, Mich., Sept. 9-11, 1914. Chicago (608 City Hall): S. H. Viall, Secretary. Paper; 6x9 in.; pp. 79.

THE MANNHEIM (COMPLETE MANUAL) AND THE DUPLEX SLIDE RULES—By William Cox. Hoboken, N. J.: Keuffel & Esser Co. Paper: 6x9 in.; pp. 60; illustrated. 50c.

MODERN PLUMBING ILLUSTRATED: A Comprehensive and Thoroughly Practical Work on the Modern and Most Approved Methods of Plumbing Construction; the Standard Work for Plumbers, Architects, Builders, Property Owners, Boards of Health and Plumbing Examiners, and for Trade Classes in Plumbing—By R. M. Starbuck, Author of "Questions and Answers on the Practice and Theory of Sanitary Plumbing" (2 Vols.), "Questions and Answers on the Practice and Theory of Steam and Hot Water Hesting," "Mechanical Drawing for Plumbers," etc. Third Edition Revised and Enlarged. New York: Norman W. Henley Publishing Co. Cloth; 8x11 in.; pp. 407; fully illustrated by 58 detailed plates made expressly by the author for this work. $4.

LEVEE AND DRAINAGE LAWS OF TEXAS: Bulletin No. 4— Austin, Texas: State Reclamation Department. Paper; 6x9 in.; pp. 89.

MASONRY AS APPLIED TO CIVIL ENGINEERING: Being a Practical Treatise on the Design and Construction of Engineering Works in Stone and Heavy Concrete—Adapted for the Use of Students and Those Engaged in the Practice of the Profession by F. Noel Taylor, author of "A Manual of Civil-Engineering Practice." New York: D. Van Nostrand Co. Cloth; 6x9 in.; pp. xi + 230; 212 illustrations.

A MODEL HEALTH CODE FOR TEXAS CITIES—By Robert M. Jameson, Secretary of the Bureau of Municipal Research and Reference. Municipal Research Series No. 8. Austin, Texas: University of Texas. Paper; 6x9 in.; pp. 95.

MOTION OF LIQUIDS—By Lieut.-Col. R. De Villamil. New York: Spon & Chamberlain. London: E. & F. N. Spon, Ltd. Cloth; 6x9 in.; pp. xiv + 210; 86 illustrations and 30 tables. $2.50.

PRACTICAL MECHANICS AND ALLIED SUBJECTS—By Joseph W. L. Hale, Associate Professor of Engineering, the Pennsylvania State College, Detailed as Supervisor Apprentice Schools, Pennsylvania Lines East of Pittsburgh and Erie; Member of the National Association of Corporation Schools; Member of the National Society for the Promotion of Industrial Education; Associate Member of the American Institute of Electrical Engineers; Author of "Practical Applied Mathematics." New York and London: McGraw-Hill Book Co., Inc. Cloth; 5x7 in.; pp. 225; 201 illustrations and text figures. $1, net.

NATIONAL FIRE PROTECTION ASSOCIATION: Proceedings of Annual Meeting Held at New York City, May 11-13, 1915. Boston, Mass. (87 Milk St.): Franklin H. Wentworth, Secretary. Paper; 6x9 in.; pp. 497. For Members Only; $1 a copy.

PRACTICAL TRACK WORK—By Kenneth L. Van Auken. Chicago, Ill.: Railway Educational Press, 14 East Jackson Boulevard. Cloth; 5x8 in.; pp. 216; illustrated. $1.50.

THE PREPARATION OF FERTILIZER FROM MUNICIPAL WASTE—By J. W. Turrentine, Scientist in Soil Laboratory Investigations, Bureau of Soils. (From Yearbook of Department of Agriculture for 1914.) Washington, D. C.: Department of Agriculture. Paper; 6x9 in.; pp. 309.

THE PRINCIPLES AND PRACTICE OF LINEAR PERSPECTIVE, Developed Along Original Lines: Being a Practical Handbook for Architects, Civil and Mechanical Engineers, Art Designers, Engravers, and for Draughtsmen Engaged in All the Industrial Arts, Including a Self-Explanatory Linear Perspective Chart in Simplified Form—By Herman T. C. Kraus, C. E. Second Edition, Revised and Enlarged. New York: Norman W. Henley Publishing Co., 132 Nassau St. Cloth; 10x13 in.; pp. 53; 15 plates of practical examples. $2.50.

PUBLIC HEALTH IN SPRINGFIELD, ILLINOIS: A Survey by the Department of Surveys and Exhibits, Russell Sage Foundation—By Franz Schneider, Jr. New York: Department of Surveys and Exhibits, Russell Sage Foundation. Paper; 6x9 in.; pp. 159; illustrated. 25c.

Among other topics treated this report deals with water-supply, sewerage and sewage disposal, and typhoid fever. Among recommendations for the improvement of the health department of the city is the employment of a full-time health officer.

THE SLIDE RULE: A Practical Manual—By Charles N. Pickworth, Editor of "The Mechanical World"; author of "Logarithms for Beginners"; "The Indicator: Its Construction and Application"; "The Indicator Diagram: Its Analysis and Calculation." 13th Edition. New York: D. Van Nostrand Co. Manchester, England: Emmott & Co. Cloth; 5x8 in.; pp. 122; 37 illustrations. $1.

The preface states that the contents have been further extended so as to include descriptions of various new slide rules and calculators. A note on the extraction of fifth root, etc., has also been added.

PUBLIC SERVICE COMMISSION FOR THE FIRST DISTRICT OF THE STATE OF NEW YORK: Report for the Year Ending Dec. 31, 1913; Vol. II, Statistics of Transportation Companies. Report for the Year Ending Dec. 31, 1914; Vol. I, Report and Appendices A to D, Inclusive. Linen; 6x9 in.; pp. 861 and 813.

PUBLIC WORKS DEPARTMENT, MADRAS PRESIDENCY: Administration Report for the Year 1913-14. Part II, Irrigation. Madras, India: Irrigation Branch of the Department. Cardboard; 8x13 in.; pp. 283; illustrated. 4 shillings, 3 pence.

STANDARD HAND BOOK FOR ELECTRICAL ENGINEERS Prepared by a Staff of Specialists—Frank F. Fowle, S. B., Editor-in-Chief, Consulting Electrical Engineer, M. Am. I. E. E., Illuminating Engineering Society and National Electric Light Association. Fourth Edition, rewritten and greatly enlarged. New York and London: McGraw-Hill Book Co., Inc. Leather; 4x7 in.; pp. 1984; illustrated. $5, net.

PURCHASING: Its Economic Aspects and Proper Methods—By H. B. Twyford, Otis Elevator Co. New York: D. Van Nostrand Co. Cloth; 6x9 in.; pp. xvi + 236; 121 illustrations. $3, net.

THE THEORY AND PRACTICE OF ORE DRESSING—By Edward S. Wiard, S. B., Member, Min. and Met. Soc. of America. First Edition. New York and London: McGraw-Hill Book Co., Inc. Cloth; 6x9 in.; pp. 426; 254 text illustrations. $4, net.

ULTRA-VIOLET RAYS: A List of References to Material in the New York Public Library—Compiled by William B. Behrens, Division of Technology. Paper; 7x10 in.; pp. 20.

RESEARCH WORK, METROPOLITAN WATER BOARD. Eleventh Report—By Dr. A. C. Houston, Director of Water Examination, Metropolitan Water Board. Together with Index to Research Reports, Nos. I-X, inclusive. London, England: Metropolitan Water Board (Savoy Court, Strand, W. C.). Paper; 8x13 in.; pp. 52 + vii. 2½ shillings.

The larger part of this report is devoted to an account of a continuation of Dr. Houston's experiments on the excess lime method of water treatment. Detailed chemical and bacterial results are given. The report also contains a "Note on 'Water Microbes,' Giving the Cholera Red Reaction on First Test."

Field and Office

Cost of Fence Wire, Wood and Steel Posts

The report of the Committee on Signs, Fences and Crossings, presented at the annual meeting of the American Railway Engineering Association, gives some interesting figures of cost for two sections of test fence on the Philadelphia division of the Baltimore & Ohio R.R. One section had metal posts and the other had wood posts. Each section, erected in May, 1913, was 4620 ft. long and had electrically welded wire fence of No. 9 galvanized wires. The figures given in the report are tabulated below:

	Steel Posts	Wood
Labor, driving and tamping intermediates	$0.0573	....
Setting end or anchor posts	1.22	....
Total	$1.2773	....
Digging holes, distributing and setting	....	$0.0879
Erecting fence on posts, per rod	.18	.1576
Erecting fence on posts, per mile	57.60	50.43
Stretching wire, per rod	.0613	.0672
Stretching wire, per mile	19.62	21.50
Posts, price	.245 (line)	.18
Posts, cost in place	.3023	.2679

Relaying Street-Railway Track at Cincinnati

The Cincinnati Traction Co. has been raising its grade slightly and replacing light rails with heavy rails for about two miles on Madison Ave., practically without interruption to its traffic. The city repaved this section of the street last year. The company was not able to relay its tracks at that time, and merely filled in its space, and in some instances roughly replaced the old asphaltic concrete paving. The new work this year was thereby facilitated, as it was easy to remove the filling and get at the rails.

The earth and stone around the rails were dug out with picks, so that the spikes and splices could be removed and the rails taken up and hauled away. The excavation to grade was about 19 in. deep (below the street surface), and was made by means of a Thew shovel, operated by current taken from the trolley wire. The ties were taken up by hand as the shovel reached them. The excavated material was carried off in wagons and largely used in filling for property owners in the vicinity, the ground being very uneven. Following the shovel work, a few men trimmed the rough edges of the excavation. The surface was then rolled in readiness for the ties, which were supported at the required elevation by means of blocking.

The concrete was mixed by a Foote mixer mounted on a truck and was delivered in place by a steel spout. The mix was 1:2:7, using sand and gravel. The cement was delivered in sacks and piled at intervals along the sidewalk. Sand (and in some cases gravel) was hauled by the company's work cars and dumped along one side of the work, while most of the gravel was hauled by wagons and dumped on the opposite side in a continuous pile. Water was taken from the city's fire-plugs and paid for according to the cubic yards of concrete placed.

With this arrangement, and the mixer moving along slowly but continuously, 1020 lin.ft. of concrete base, 9½ ft. wide and 6 in. deep, was laid in one night on Vine St. On Madison Ave., however, the work was slower, as it was all done during daylight working hours, the principal interference being the operation of the cars. About 300 lin.ft. per day of work was a good average for the shovel, and about the same for the concreting.

The chief feature in the handling of the car traffic during the work was the use of a temporary third track, made up in 30-ft. sections, with steel ties, so that it could be laid or taken up rapidly. This was laid for a

MADISON AVE. STREET RAILWAY RELAYING, CINCINNATI, OHIO

Upper View—General view, showing material in place and temporary car track. Lower View—Track concrete mixer working

distance of several blocks, and advanced as the work progressed. It enabled the cars to be operated virtually without interruption, and at the same time allowed one track to be given over completely to the reconstruction work.

At one point, however, where it was desired to improve a bad curve, both tracks had to be relaid together. Up to that point the work had been handled on the outside track, while both tracks here had to be moved inward several feet. Taking advantage of a few hours of free time at night and of the short intervals between the cars, the old tracks were taken up, the new ones laid, and the concreting went ahead under the cars. The concrete was tamped with picks to insure thorough filling under the ties.

The concrete is 9 in. thick and comes within 3 in. of the top of the ties. After this has set, the paving contractor places 6 in. of concrete (of the same mixture), which leaves just room enough for the granite paving blocks. The laying of these completes the job.

The work was under the direction of C. Henderson, Engineer for the company, with J. Hysam as Superintendent.

Reducing Square Feet to Decimals of Acres

The accompanying table has been found valuable for readily and accurately determining the areas of small tracts of land. In making descriptions to be embodied in a deed after the area has been determined in square feet, the acreage can be obtained by reading directly from the table for areas between 0 and 1000 sq.ft. and by a single mental addition for areas between 1000 and 100,000 sq.ft. Thus for 665 sq.ft. follow down the column headed 600 to line opposite 60 and find 0.01515. In same column on line opposite 70 find 0.01538. So 665 sq.ft. equals 0.015+ acre. Again, suppose the area is 49,524 sq.ft. In column headed 500 on line 40,000 read 0.92975. In column headed 0 on line 20 read 0.00046 and on line 30 read 0.00069. Hence interpolating for 24 ft. and adding gives 0.930 acre as the area to the nearest thousandth of an acre for 40,524 sq.ft. There is an interesting fact in connection with the making of this table, namely, the use of a computing machine, which can be used in a like manner to advantage in making any similar table. By starting in a column headed 0 and reading down to line 90, then beginning at the top of column headed 100 and reading down to line 90 and continuing reading in this way across the sheet to 990, it is observed that there is a regular increase of 10 sq.ft. each time. The value of 10 sq.ft. in acres is determined to the eighth figure beyond the decimal. This is placed in the "Millionaire" computing machine with the regulator set on addition and the multiplier lever set at 1. Then the crank is turned with the left hand and the results after each turn are set down with the right from 10 sq.ft. to 1000 sq.ft.

TABLE OF SQUARE FEET REDUCED TO DECIMALS OF AN ACRE

Feet	0	100	200	300	400	500	600	700	800	900
0	0.00000	0.00230	0.00459	0.00689	0.00918	0.01148	0.01377	0.01607	0.01837	0.02066
10	0.00023	0.00253	0.00482	0.00712	0.00941	0.0171	0.01400	0.01630	0.01859	0.02089
20	0.00046	0.00275	0.00505	0.00735	0.00964	0.01194	0.01423	0.01653	0.01882	0.02112
30	0.00069	0.00298	0.00528	0.00758	0.00987	0.01217	0.01446	0.01676	0.01905	0.02135
40	0.00092	0.00321	0.00551	0.00781	0.01010	0.01240	0.01469	0.01699	0.01928	0.02158
50	0.00115	0.00344	0.00574	0.00803	0.01033	0.01263	0.01492	0.01722	0.01951	0.02181
60	0.00138	0.00367	0.00597	0.00826	0.01056	0.01286	0.01515	0.01745	0.01974	0.02204
70	0.00161	0.00390	0.00620	0.00849	0.01079	0.01309	0.01538	0.01768	0.01997	0.02227
80	0.00184	0.00413	0.00643	0.00872	0.01102	0.01331	0.01561	0.01791	0.02020	0.02250
90	0.00207	0.00436	0.00666	0.00895	0.01125	0.01354	0.01584	0.01814	0.02043	0.02273
1,000	0.02296	0.02525	0.02755	0.02984	0.03214	0.03444	0.03673	0.03903	0.04132	0.04362
2,000	0.04591	0.04821	0.05050	0.05280	0.05510	0.05739	0.05969	0.06198	0.06428	0.06657
3,000	0.06887	0.07117	0.07346	0.07576	0.07805	0.08035	0.08264	0.08494	0.08724	0.08953
4,000	0.09183	0.09412	0.09642	0.09871	0.10101	0.10331	0.10560	0.10790	0.11019	0.11249
5,000	0.11478	0.11708	0.11938	0.12167	0.12397	0.12626	0.12856	0.13085	0.13315	0.13545
6,000	0.13774	0.14004	0.14233	0.14463	0.14692	0.14922	0.15151	0.15381	0.15611	0.15840
7,000	0.16070	0.16299	0.16529	0.16758	0.16988	0.17218	0.17447	0.17677	0.17906	0.18136
8,000	0.18365	0.18595	0.18825	0.19054	0.19284	0.19513	0.19743	0.19972	0.20202	0.20432
9,000	0.20661	0.20891	0.21120	0.21350	0.21579	0.21809	0.22039	0.22268	0.22498	0.22727
10,000	0.22957	0.23186	0.23416	0.23646	0.23875	0.24105	0.24334	0.24564	0.24793	0.25023
11,000	0.25252	0.25482	0.25712	0.25941	0.26171	0.26400	0.26630	0.26859	0.27089	0.27319
12,000	0.27548	0.27778	0.28007	0.28237	0.28466	0.28696	0.28926	0.29155	0.29385	0.29614
13,000	0.29844	0.30073	0.30303	0.30533	0.30762	0.30992	0.31221	0.31451	0.31680	0.31910
14,000	0.32140	0.32369	0.32599	0.32828	0.33058	0.33287	0.33517	0.33746	0.33976	0.34206
15,000	0.34435	0.34665	0.34894	0.35124	0.35353	0.35583	0.35813	0.36042	0.36272	0.36501
16,000	0.36731	0.36960	0.37190	0.37420	0.37649	0.37879	0.38108	0.38338	0.38567	0.38797
17,000	0.39027	0.39256	0.39486	0.39715	0.39945	0.40174	0.40404	0.40634	0.40863	0.41093
18,000	0.41322	0.41552	0.41781	0.42011	0.42241	0.42470	0.42700	0.42929	0.43159	0.43388
19,000	0.43618	0.43847	0.44077	0.44307	0.44536	0.44766	0.44995	0.45225	0.45454	0.45684
20,000	0.45914	0.46143	0.46373	0.46602	0.46832	0.47061	0.47291	0.47521	0.47750	0.47980
21,000	0.48209	0.48439	0.48668	0.48898	0.49128	0.49357	0.49587	0.49816	0.50046	0.50275
22,000	0.50505	0.50735	0.50964	0.51194	0.51423	0.51653	0.51882	0.52112	0.52342	0.52571
23,000	0.52801	0.53030	0.53260	0.53489	0.53719	0.53948	0.54178	0.54408	0.54637	0.54867
24,000	0.55096	0.55326	0.55555	0.55785	0.56015	0.56244	0.56474	0.56703	0.56933	0.57162
25,000	0.57392	0.57622	0.57851	0.58081	0.58310	0.58540	0.58769	0.58999	0.59229	0.59458
26,000	0.59688	0.59917	0.60147	0.60376	0.60606	0.60836	0.61065	0.61295	0.61524	0.61754
27,000	0.61983	0.62213	0.62242	0.62672	0.62902	0.63131	0.63361	0.63590	0.63820	0.64049
28,000	0.64279	0.64509	0.64738	0.64968	0.65197	0.65427	0.65656	0.65886	0.66116	0.66345
29,000	0.66575	0.66804	0.67034	0.67263	0.67493	0.67723	0.67952	0.68182	0.68411	0.68641
30,000	0.68870	0.69100	0.69330	0.69559	0.69789	0.70018	0.70248	0.70477	0.70707	0.70937
31,000	0.71166	0.71396	0.71625	0.71855	0.72084	0.72314	0.72543	0.72773	0.73003	0.73232
32,000	0.73462	0.73691	0.73921	0.74150	0.74380	0.74610	0.74839	0.75069	0.75298	0.75528
33,000	0.75757	0.75987	0.76217	0.76446	0.76676	0.76905	0.77135	0.77364	0.77594	0.77824
34,000	0.78053	0.78283	0.78512	0.78742	0.78971	0.79201	0.79431	0.79660	0.79890	0.80119
35,000	0.80349	0.80578	0.80808	0.81038	0.81267	0.81497	0.81726	0.81596	0.82185	0.82415
36,000	0.82644	0.82874	0.83104	0.83333	0.83563	0.83792	0.84022	0.84251	0.84481	0.84711
37,000	0.84940	0.85170	0.85399	0.85629	0.85858	0.86088	0.86318	0.86547	0.86777	0.87006
38,000	0.87236	0.87465	0.87695	0.87925	0.88154	0.88384	0.88613	0.88843	0.89072	0.89302
39,000	0.89532	0.89761	0.89991	0.90220	0.90450	0.90679	0.90909	0.91138	0.91368	0.91598
40,000	0.91827	0.92057	0.92286	0.92516	0.92745	0.92975	0.93205	0.93434	0.93664	0.93893
41,000	0.94123	0.94352	0.94582	0.94812	0.95041	0.95271	0.95500	0.95730	0.95959	0.96189
42,000	0.96419	0.96648	0.96878	0.97107	0.97337	0.97566	0.97796	0.98206	0.98255	0.98485
43,000	0.98714	0.98944	0.99173	0.99403	0.99633	0.99862	1.00092	1.00321	1.00551	1.00780

	0	1000	2000	3000	4000	5000	6000	7000	8000	9000
40,000	0.91827	0.94123	0.96419	0.98714	1.01010	1.03306	1.05601	1.07897	1.10193	1.12488
50,000	1.14784	1.17080	1.19375	1.21671	1.23967	1.26262	1.28558	1.30854	1.33149	1.35445
60,000	1.37741	1.40036	1.42332	1.44628	1.46924	1.49219	1.51515	1.53811	1.56106	1.58402
70,000	1.60698	1.62993	1.65289	1.67585	1.69880	1.72176	1.74472	1.76767	1.79063	1.81359
80,000	1.83654	1.85950	1.88246	1.90541	1.92837	1.95133	1.97428	1.99724	2.02020	2.04316
90,000	2.06611	2.08907	2.11203	2.13498	2.15794	2.18090	2.20385	2.22681	.24977	2.27272

100,000	2.00000	3.00000	4.00000	5.00000	6.00000	7.00000	8.00000	9.00000	10.00000
2.29568	4.59136	6.88704	9.18272	11.47840	13.77408	16.06976	18.36544	20.66112	22.95680

[The "Millionaire" computing machine[1] is of Swiss manufacture and is claimed to be the only computing machine that operates on the multiplication principle. Only one turn of the crank is required for each figure in the multiplier or quotient, instead of one turn for each unit of each figure, as with machines which operate on the addition principle.—Editor.] A single shift of the carriage gives the value for 100 sq.ft. to be added each time in the part of the table commencing 1000 and the process of turning with left hand and setting down results with the right continues, excepting that we now go across the lines instead of running down the columns. After computing the values to 43,900 sq.ft., another shift in the carriage is made to give the value of 1000 sq.ft. each time, and the value of 40,000 sq.ft., already found, set in the sum column on the machine. Another shift at 100,000 for the value of 100,000 and the table is carried to completion with very little labor.—B. F. Sperow, Carolina, Clinchfield & Ohio Ry., Johnson City, Tenn.

[The above indicates one of the many uses that may be made of a computing machine in engineering offices. Apparently because of their high cost, engineers have been reluctant to adopt mechanical devices for those tiresome and routine computations which have been the bane of many a man's practice. For computations in banking and insurance offices mechanical computers are now used exclusively. An article descriptive of other computing machines and their use for survey work was published in *Engineering News*, Jan. 7, 1915.—Editor.]

[1]Made by Hans W. Egli, Zurich, Switzerland, and handled in America by W. A. Morschhauser, 1 Madison Ave., New York City.

Retracing Old Compound Railway Curves

By F. W. Green*

In retracing old railway curves, it is sometimes found that the original notes and chaining show considerable discrepancies. When compound curves are to be re-established any discrepancy in the chaining is likely to cause inconvenience. In such cases, when the notes show the degree of curve for each branch, it is a simple matter to locate the P.C. and P.T., and then to chain the distance

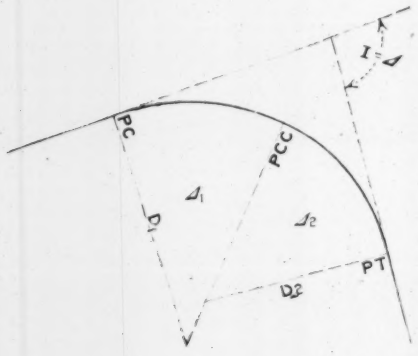


DIAGRAM OF COMPOUND CURVE TO BE RETRACED

from P.C. to P.T. The P.C.C. may then readily be located by the following method, which, so far as I can learn, is original:

(1) Given a compound curve (as in the accompanying plan), the intersection angle I, the location of P.C. and P.T., and degrees of curves D_1 and D_2; to find the station of the P.C.C. Let L_1 be the length of first curve, in stations; L_2 the length of second curve, and L the length of both curves. And let $I = \Delta$. Then:

$$\frac{\Delta - \Delta_2}{D_1} + \frac{\Delta_2}{D_2} = L.$$

Example: P.C. at Sta. 5502 + 00, $D_1 = 1°$, $D_2 = 2°$
$L = 27.37$, $\Delta = 38° 15'$

$$\frac{38.25 - \Delta_2}{1} + \frac{\Delta_2}{2} = 27.37$$

Whence: $\Delta_2 = 21.76° = 21° 45.6'$

$$L_2 = \frac{21.75}{2} = 10.88$$

$L - L_2 = L_1 = 27.37 - 10.88 = 16.49.$

Sta. of P.C. = 5502 + 00
Add L_1 = 16 + 49
Sta. of P.C.C. = 5518 + 49
Add L_2 = 10 + 88
Sta. of P.T. = 5529 + 37

(2) Given Δ_2 and Δ; D_1 and L; to find D_2

Transposing (1); $$D_2 = \frac{\Delta_2}{L - \frac{\Delta - \Delta_2}{D_1}}$$

Example: $\Delta_2 = 21.76$, $L = 27.37$, $\Delta = 38.25$; $D_1 = 1°$

$$D_2 = \frac{21.76}{27.37 - \frac{38.25 - 21.76}{1}} = 2°$$

Installing a Half-Mile Sewer System; Gilbert, Minn.

In the spring of 1915 the village of Gilbert, Minn., built about 3000 ft. of 8-in. pipe sewers in a recently annexed territory. The attached cost analysis shows how cheaply this work was done by municipal day labor. The rates of wages paid for an 8-hr. day were: Common labor, $2.25; teams, $5.50; masons, $6.40; pipe layer, $2.75. The average cost per linear foot of sewer completed, including manholes, was $1.50.

The sewer main to which these new sewers were to be connected was at a depth of 7½ ft. At the junction, a hole 7 ft. in diameter was dug uncovering about 4 ft. of the pipe. A manhole was then built over the pipe with the 8-in. pipe connection for the new sewer through the wall. The main sewer was then broken and the concrete invert through the manhole completed. The

COSTS, GILBERT, MINN., SEWERS
Started May 1, 1915, Finished June 14, 1915

Line A, 885 ft. in Length	
Excavation	$675.00
4 manholes	216.24
8-in. pipe and Y's	160.59
Filling trench	175.26
Teams and cement	33.55
Labor for laying pipe	43.00
Engineering and foreman	105.00
Total cost for line	$1408.64
Line C, 1037 ft. in Length	
Excavation	$747.00
5 manholes	283.59
8-in. pipe and Y's	201.94
Filling trench	194.00
Teams and cement	65.45
Labor for laying pipe	50.00
Engineering and foreman	80.00
	35.00
Total cost for line	$1656.98
Line E, 1053 ft. in Length	
Excavation	$488.48
3 manholes	124.87
8-in. pipe and Y's	200.07
Filling trench	146.25
Teams and cement	31.05
Labor for laying pipe	40.00
Engineering and foreman	70.00
Total cost for line	$1100.72
12 manholes cost $624.67. Average cost per manhole $52.05.	
Approx. 2479 cu.yd. earth, $1910.48. Average of 77c. per cu.yd.	
2479 cu.yd. filling, $515.51. Average of 20c. per cu.yd. (hand filling).	
2975 ft. of pipe laid for $133.00. Average of 0.0475c. per lin.ft.	
8-in. tile sewer pipe @ 18¾c. per lin.ft. Sand-lime bricks @ $12 per M.	
Line A, total cost	$1408.64
Line C, total cost	1656.98
Line E, total cost	1100.72
Total cost of system	$4166.34
Cost of lumber	72.05

trench for the new sewer was started at the manhole, and as fast as the excavation was brought to grade, the pipe was laid and used to drain off any water which came into the trench.

In one of the trenches quicksand of the worst sort was encountered, and the ditch could not be kept open five minutes with the ordinary bracing. After trying many methods the following one succeeded: Iron rods, 2 in. in diameter, about 10 ft. long, were driven at intervals of 5 ft. Pieces of 2-in. plank 24 ft. long were laid horizontally, behind the rods, and between the planking and the sand hay and green boughs were wedged as tightly as possible.

White sand-lime brick costing $12 per M were used for building the manholes. Instead of using the ordinary tile stoppers for the Y's, galvanized-iron covers were put

in. When the Y's were ready to be opened and connected to the house drains, a hook was stuck into the cover and it came out easily. Tile covers have to be broken, and the chances are that part of the cover goes into the pipe. The 8-in. tile pipe cost 18¾c. per lin.ft., and the Y's, 6x8 in., cost 75c. each.—A Cohn, Gilbert, Minn.

Steam Shovel Burrows Its Way Out of Cut

The accompanying photographs, taken May 3, illustrate resourcefulness in operating a steam shovel. The shovel shown herewith was used in making the second cut in

FIGS. 1 AND 2. VIEWS OF STEAM SHOVEL DIGGING ITS WAY OUT OF CUT

Fig. 1—Timbering of second cut shown in rear. Fig. 2—Shovel nearing the completed tubes of Long Island R.R., in East New York. Observe character of side slopes in both views

a section of the grade-crossing elimination work which the Long Island R.R. has had under way for the last three years in East New York.

When this section of the second cut had been finished, the disposition of the shovel presented something of a problem. It would not do to lift it out of the cut, because the slopes might slide, nor could it be backed out by the way it had entered, because of the timbering shown in the rear, Fig. 1.

The four tubes of the tunnel had been completed to a point where the second cut on this section began. It was decided that the simplest way of moving the shovel to the surface was to have it dig its way down to one of the concrete tubes, the floor of which was 22 ft. below the floor of the second cut, and then to run the shovel out to the portal on the track laid inside the tube.

The spoil handled by the shovel was lifted out of the cut by a crane equipped with a bucket. In order to keep the water distributed uniformly in the boiler and the fire burning properly, the rear truck of the shovel was removed and the shovel was skidded on timbers down an 18-per cent. grade. Walter H. Gahagan, the contractor, states that the entire operation was performed without any particular difficulty.

Erection of Steel Arch Span, Detroit-Superior Viaduct

Cantilever erection of the 591-ft. steel arch forming the main span of the new Detroit-Superior viaduct in Cleveland is being carried on with unusually simple plant for so large a span. The principal work will be done by a timber top-chord traveler carrying two 25-ton stiff-leg derricks which were previously used on the ground in setting anchorage steel. The total weight of the traveler with derricks and hoisting engines is only about 70 tons. The hoists are 52-hp. electric machines built by the Thomas Elevator Co., Chicago. They have a pulling capacity of from 7500 to 8000 lb.

The traveler rolls on a track made of two 8x16-in. timbers laid flat side by side, resting on 8x8-in. by 3½-ft. ties laid on the top chord. In the three end panels of the arch the track is above the chord (being started on a flatter slope than the end sections of the top chord), and the track stringers rest on short falsework bents set on the chord. Beyond this portion of the track the traveler carriage follows the changing slope of the top chord, but the derricks are kept vertical by an adjustable link connecting a shoe at the rear end of the fore-and-aft leg to the back of the carriage (see Fig. 1).

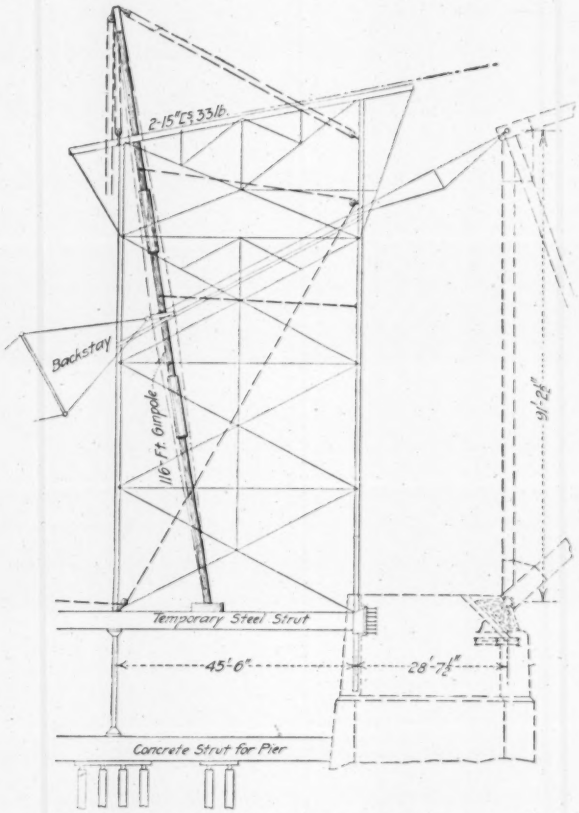


FIG. 2. GIN-POLE USED IN ERECTING TOWER

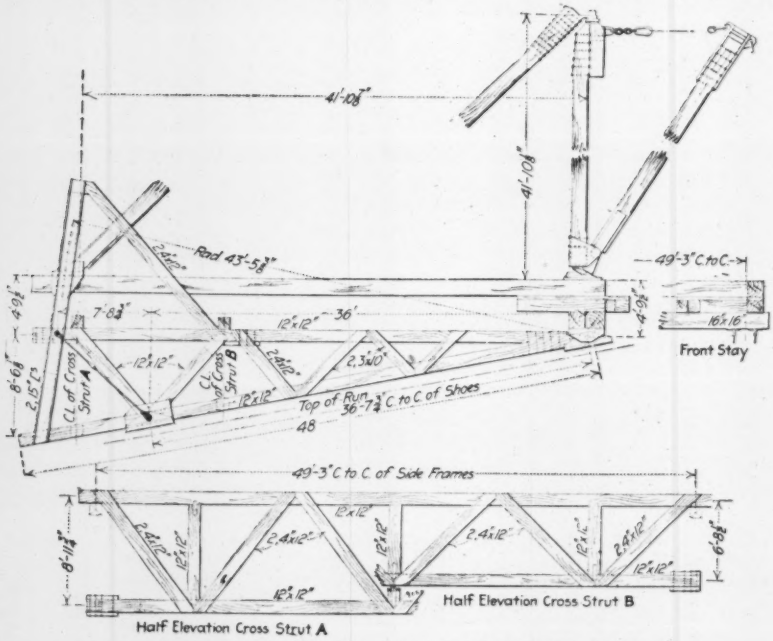


FIG. 1. ERECTION TRAVELER, DETROIT-SUPERIOR ARCH

The capacity of either derrick is sufficient to lift the heaviest member other than the lower-chord end section. Most of the material will be hoisted from scows in the river direct to place in the arch. Working forward from both piers to junction in the middle, the travelers will erect only the arches and their bracing. Then returning, they will placethe floor steel—two decks, the whole viaduct being a double-deck structure.

The eyebar backstays which hold the half-arches in place until joined at the center are remarkable for the shape of the toggle, which has least depth at the screw, so as to put the screw in tension.[1]

[1]See sketch in "Engineering News," of June 18, 1914, p. 1348, where drawings and details of the bridge are also given.

To carry the weight of backstay and toggle, and to support the traveler at the start, a steel erection tower has been built behind the main pier, on each bank. These towers were erected by a gin-pole. As the towers are about 90 ft. high, a 116-ft. gin-pole was built, shown in sketch Fig. 2. It was made of three lengths of 12x12, spliced at both joints by four 12-ft. pieces of 4x12, bolted through, and was stayed by four hog-rods made of ⅝-in. wire rope with turnbuckle connection at the bottom to a 1-in. rod. Four sets of double-part 1-in. guy lines extended back to blocks hitched to the tower, and led down the pole to a fastening at the foot. The pole was further steadied by a belly-guy near the upper quarter-point, leading through a snatch-block on the tower to a spool on the engine so that a strain could be held on it; and by a pair of slack guys lower down, near the middle of the length, hitched to two posts of the tower back of the pole.

This gin-pole was first set by a derrick at the lowest falsework level, to erect the lower part of the tower; later it was lifted to the level of the pier top, and in this position erected the upper part of the tower and the traveler carriage; it was then hoisted another story, to lift the first derrick to place. After the pole erected the east tower it was dismantled and reërected on the west bank (Fig. 4).

In erecting the first arch steel the backstays can not be used because they connect to the end pin of the top chord, which pin can be driven only after the entire first panel is in place. The first panel is therefore being set on falsework comprising a framed bent of 12x12's, set on the ground to support the lower chord just back of the first panel-point.

The first panel includes the heaviest member of the arch—the 30-ton end section of the lower chord. As

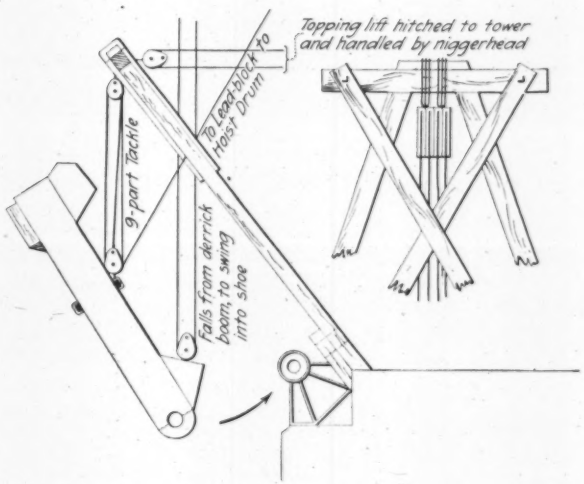

Topping lift hitched to tower and handled by niggerhead
To Lead-block to Hoist Drum
9-part Tackle
Falls from derrick boom to swing into shoe
L2
U2

FIG. 3. SETTING OF SHEER-LEGS FOR HOISTING 30-TON CHORD

the traveler derricks could not safely lift this from their position on the forward overhang of the erection tower (Fig. 2), a pair of sheer-legs was set on the front edge of the pier, as shown by Fig. 3. With a 9-part hoisting tackle, this handles the weight of the chord-section from the ground; the derrick-falls then swing the L0 point to seat in the shoe.

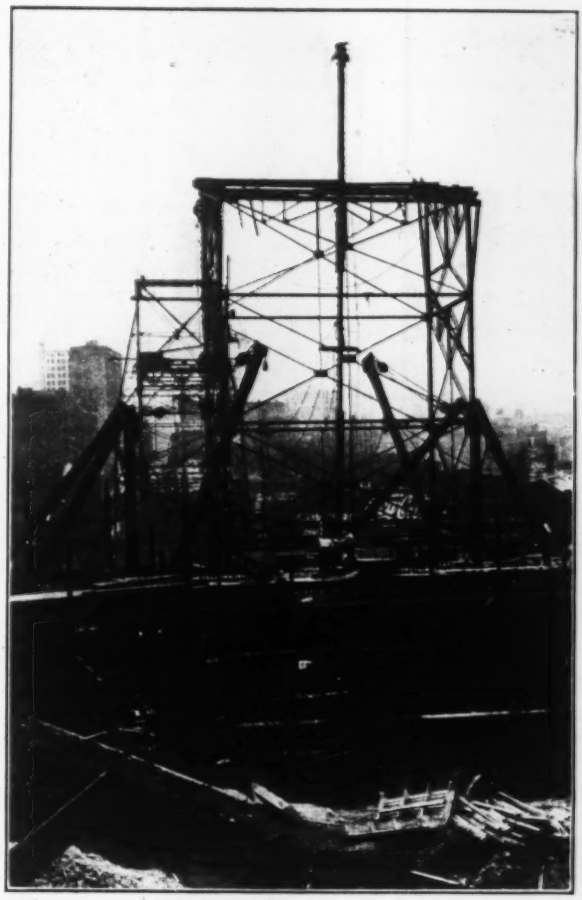


FIG. 4. GIN-POLE 116 FT. HIGH, ERECTING WEST TRAVELER TOWER

Lower story of tower is concealed by pier 2. The gin-pole is stepped at the level of the bottom of the lower story

The arch panels are about 25 ft. long (24 panels = 591 ft.). The traveler will have to make a maximum reach of about 32 ft. in lifting steel from scows. The heaviest member it must handle is the 23½-ton post U2 L2.

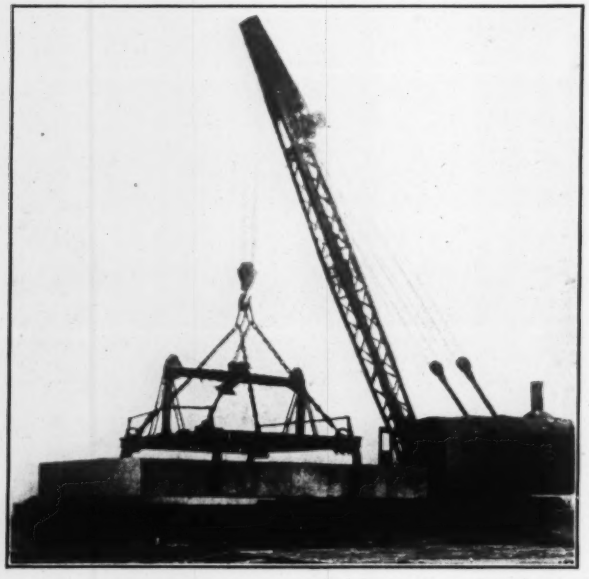
The Ferro Construction Co., of Chicago, is erecting the arch; F. C. Fisher, President, designed the erection appliances. Both the arch steel and the traveler tower were fabricated by the King Bridge Co., of Cleveland. F. F. Buck, superintendent of erection, is in charge of the field work for the Ferro Construction Co. The first steel of the main arch was set July 29, as noted in the news pages of *Engineering News* of Aug. 5, 1915. It is expected that the arch will be closed by October, and the floor put in place by the end of the year.

Beaching a Vessel at High Tide for repairs to the hull is very common practice in the case of small vessels, and has been resorted to at the Pacific end of the Panama Canal for even such large vessels as the seagoing suction dredge "Culebra." As the range of tidal levels at the Pacific end is 20 to 21 ft., a vessel beached at high tide on the broad, sloping, sandy beach will be left high and dry at low tide. This method has been so successful with large-size vessels that, although a dry dock is now available at Panama, the "Culebra" was recently beached for minor exterior repairs to her hull because the work could be done in that way more cheaply and quickly than by drydocking.

Handling 62-Ton Concrete Blocks at Halifax

In the construction of the new Ocean Terminals for the Canadian Government Railways at Halifax, N. S., the quay walls are being formed of huge concrete blocks, most of which are 22x31 ft. in plan and 4 ft. thick. These are cast with a number of vertical openings and laid in place in the quay wall one on top of the other. The openings are matched and later filled with concrete so as to form a continuous solid wall 31 ft. wide.

For handling these blocks, the largest of which weigh 62 tons each, the crane shown in the accompanying view is being used. This is a regular "160-ton wrecking crane," made by the Industrial Works, of Bay City, Mich., equipped with a lattice boom instead of the ordinary crane arm. It was designed to handle a load of 70½ tons at approximately 33 ft. radius. As is shown in the view, the handling is facilitated by the use of a fairly compli-



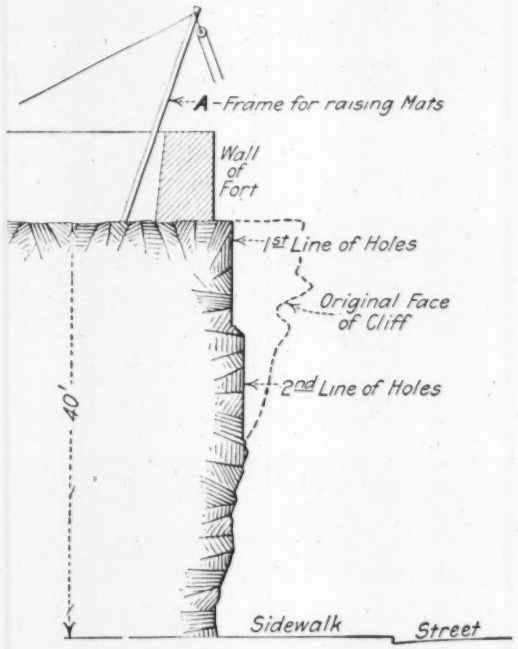
A TRACK CRANE LIFTING A 60-TON CONCRETE BLOCK AT HALIFAX TERMINAL

cated sling made of a structural frame provided with hooks controlled by a toggle-lift.

The work is in charge of James McGregor, Superintending Engineer for the Halifax Ocean Terminals, and is being executed by Foley Bros., Welch Stewart & Farquier, for whom L. G. Fuller is Superintendent.

NOTES

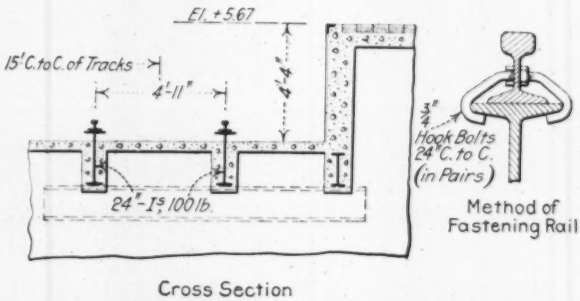
Facing-Off an Overhanging Cliff—Trimming a jagged cliff on which is perched Fort Horn, a relic of the days when the Indians threatened Manhattan Island, was a problem undertaken recently by the Degnon Contracting Co. for the Parks Department of New York City. About 25 years ago 123rd St. was cut through to the general level of the region north of Morningside Heights and as a result, Fort Horn, which consists of three rubble stone walls about 7 ft. high and 5 ft. thick built around three sides of a 30-ft. square, was left perched on the edge of a 40-ft. cliff. Deep holes and heavy charges of explosive had been used, and the rock in the upper part was badly shattered, so that later it began to crumble and pieces continued to slip down on the sidewalk below. To face off this cliff and eliminate the danger from falling fragments a line of 8-ft. holes on 4-in. centers was drilled the length of the dangerous portion (about 60 ft.), 18 in. out from the wall of the fort. A second row of holes was then drilled, starting at the foot of the first line, as shown in the accompanying sketch. After the bulk had been shot away, the face was carefully scaled. For the drilling, a gasoline air compressor of 150 cu.ft. of free air per minute capacity was set up near the foot of the cliff and served to operate two and



TYPICAL SECTION THROUGH FORT HORN

sometimes three "Jackhamer" precussion hand drills. The drill steels were made in 2-, 4-, 6- and 8-ft. lengths, with the starters 2 in. in diameter, and were gaged ⅛ in. between changes. Six-point bits were used as being less likely to stick in the seams. With a 60-lb. air pressure the actual drilling time for an 8-ft. hole in sound rock (Manhattan schist) was about 40 min. Ten holes were a good day's work. The drillrunners worked with ropes around them as a precaution in case of a slip. Each shot was covered by heavy rope mats held by blocks-and-falls from A-frames set back of the wall. About 100 cu.yd. of rock was removed without accident. Ed Connors was general foreman for the contractor.—Francis Donaldson, New York City.

A Special Track Design has been adopted for the depressed railway tracks on the new Southwark Piers now being completed by the Department of Wharves, Docks and Ferries, of Philadelphia, Penn. The main structure carrying the track consists of concrete crosswalls with embedded I-beams on



METHOD OF CARRYING RAILWAY TRACK ON SOUTHWARK PIERS, PHILADELPHIA

which rest stringers of I-beams embedded in concrete. The upper parts of these stringers protrude above the concrete and carry the track rails laid directly on the stringers. The details of the design and the method of fastening the rail to the stringers are shown in the accompanying drawing. This fastening consists of hook-bolts arranged in pairs and spaced at intervals of 2 ft. John Meigs is Director of the Department.

Editorials

Delays in Flood Protection

Flood-protective construction is easily the livest issue in the civil-engineering field at the present time. The organization of the Miami conservancy district and other reclamation districts in Ohio after more than a year of legal discussion means the start of definite planning on a large scale for many millions of expenditure.

It is a misfortune that the work has not yet reached the construction stage. With the contracting business in a state of starvation, as it is, the dike and dam and dredging contracts of Central States flood protection would have been a most desirable item to help in keeping the business alive and to maintain contractors' working organizations. The low contract prices which now prevail would not have been affected, so that the people who need the flood protection would have benefited in fullest measure from the slack condition of the business.

The reason why these desirable results are not realized is the fact that an excessive mental inertia had to be overcome. The teachings of the great flood—that protective works are urgently necessary—did not sink in. No city, county or state was willing to start. Not only this, but the Ohio Legislature directly evaded the problem; amid political intrigues it hurried its session to an end and adjourned, leaving the flood problem untouched for many months. The people of Columbus even rejected by popular vote a definite project for local protection. Under these circumstances one need not be surprised that it has taken more than two years to get the planning started and that the 1915 season finds practically no flood-protective work under way.

The destruction wrought by the Erie freshet ought to act as a warning alarm to those who still feel unsympathetic toward the movement for stream control. It directs attention also to the potential dangers residing in small streams. Heretofore it was commonly thought that the hydraulic possibilities of brooks and creeks are well known, since they are likely to get their maximum flow from a local thunderstorm. The Erie experience destroys this belief and shows that even insignificant little rivers need study and control.

Estimating the Value of New Inventions

The recent move made by Secretary Daniels to establish in the Navy Department a New Inventions Board to examine new inventions offered to the navy and select for development such as appear to be of promise calls attention to a very difficult but very important class of engineering work.

Many business men and not a few engineers look upon all work of this sort with frank skepticism. They will flatly deny that anyone, no matter what his experience and technical acquirements, is competent to pass judgment upon the merits of a new and untried invention and to say in advance of its actual demonstration whether it is promising or worthless.

In fairness to those who hold this belief, it should be said that in many cases where an opinion has to be given upon a new and wholly untried invention, the opinions of even the best technical experts may prove mistaken. Some factor which has not been taken into account may eventually cause a very promising invention to fail; or on the other hand may make a success of an invention which seemed hopeless.

But because an engineer's opinion on the merit of an invention may be in error is no more reason for rejecting it as worthless than it would be to reject the opinion of an attorney on a difficult legal question or that of a physician called in consultation in a serious case. The engineer who is competent to pass upon the merits of a new invention can give an opinion at least as reliable as the opinion of the able lawyer or the famous physician.

Further, the engineer can do what the lawyer or the physician cannot, that is, resort to physical tests to determine doubtful points and thus gradually accumulate data on which a reliable opinion can be based. This course will very often be advisable in the case of new inventions of radical novelty. Before deciding whether a new scheme is worth taking up for commercial development, tests of some of its cardinal features can be made, which will show whether its design is based on correct principles.

There is another reason for the widespread belief that nobody can tell in advance whether a new invention will succeed or fail. And this reason is that engineers competent to examine and pass upon new inventions and plan the development of those which are approved are comparatively rare.

It need hardly be said that if an engineer is to form reliable judgment upon the merits of an invention, he must be reasonably familiar with the art to which the invention applies. Hardly less important is it that he be of a fairminded and judical disposition and able to weigh without prejudice the claims of the inventor. A very large proportion of engineers are constitutionally disqualified for undertaking work of this sort. When an engineer is thoroughly familiar with an art he often acquires an unconscious prejudice against anything new and revolutionary which is proposed in it. He will demand of the inventor of a new appliance that it shall reach a degree of perfection in operation which old and familiar appliances have never attained. Such an engineer overlooks the defects in the methods and materials and appliances with which he is familiar because ways have been established for getting along with them, and he fails to appreciate that similar ways would eventually be found for the new and revolutionary method or appliance which is offered. It is the mental inertia of men of this class which makes the task of the inventor of a new appliance so difficult, as a rule.

While engineers with such a mental habit are disqualified for the task of passing on new inventions, there are engineers of another class who are equally disqualified.

These are the men of such sanguine temperament that they see advantages in everything new and fail to appreciate adequately the troubles that may develop.

One of the commonest mistakes made by engineers in passing upon inventions is to reject a scheme offhand because it is not new. Of course, from the limited point of view of patent protection the question of novelty is of importance; but in considering whether an invention may have merits justifying commercial development the matter of novelty should take a subordinate place. An invention may be brought forward and prove a failure at one time and after years of neglect it may again be taken up and the progress of the arts in the intermediate period may make it a great commercial success. Ball and roller bearings to reduce friction were invented very early in the history of mechanics, but they did not become of commercial importance until the development of accurate mechanical processes of producing balls and rollers at low cost made such bearings commercially practicable. Their extensive use, however, has come in very recent years, when instead of being made to order in small quantities such bearings are put on the market in standard sizes at so low a figure as to be available for use without serious expense in ordinary machine design.

Another highly important question to be settled in passing upon a new invention is that of its advantage over existing practice. Hundreds of ingenious schemes are brought forward every year to overcome difficulties that exist chiefly in the imagination of the inventor. An engineer must be intimate enough with an art to weigh fairly the advantages which the new invention proposes to establish over previous practice.

It is well to bear in mind also that the work of a competent "new inventions board," such as is proposed for the navy, and such as actually exist in the organization of progressive industrial concerns, is only begun when the promising new inventions are sifted out from among the impossible ones. The next step is to develop the selected inventions to the stage of mechanical and commercial success, and here again engineering ability of the very highest order is called for if the work is to be done with economy and practical advantage.

It will be evident that the work of a "new inventions board" is not a task to be undertaken by a set of men whose time is already fully occupied with their own business and professional work, such as those whose names have been announced from Washington. Nor is it work that can properly be done as a free contribution to the country's welfare. There is no more reason why such important and valuable work should be done for the Government without payment by members of the engineering profession than there is to expect the Government's most difficult tasks in the Department of Justice to be performed gratis by a committee of lawyers.

It is to be hoped that the eminent engineers and inventors and manufacturers who are to be brought together in the New Inventions Board may have a clear appreciation of the task before the Government and the way it should be handled, and that they may induce Congress to provide ways and means for the organization of such a board on a permanent basis, with a corps of carefully selected and well paid experts to carry on its work. By such means, and such means only, can the United States Navy be enabled to keep pace with its foreign rivals in the race for efficiency.

Assessing Costs of Railway Grade-Crossing Removal

In the present general scheme of railway improvement a prominent and costly item is the elimination of street crossings at grade in cities and towns. Work of this kind is in progress and in contemplation in many places, and is increasing steadily. It applies not only to the large cities but also to many smaller places where the danger or interruption to traffic reaches a degree that leads the municipality to demand an improvement in the conditions.

The aggregate cost of this work is enormous, and by far the greater proportion of this cost is paid by the railways. On the other hand, the benefits are mainly in the interests of the public and the municipality. Such benefits as accrue to the railway result from a reduction in liability to accidents and claims for damages and some greater facility in handling the traffic, especially where traffic is heavy and movements are hampered by a long succession of crossings, with their gates and watchmen. In certain cases the elimination of crossings may effect or permit a reduction in grade or other similar improvement, but such incidental improvement is obtained usually at a cost far in excess of the value of the improvement, and far beyond what the railway could reasonably or economically pay under ordinary conditions.

The work is of a costly character throughout. Limitations of right-of-way and cost of land usually necessitate masonry retaining walls for either a cut or a fill. The bridge work is costly, and must usually provide for solid waterproof decks. In many cases ornamental treatment of the metal work, or its incasement in concrete with such treatment, adds materially to the cost of the bridges. In addition to this every case involves special problems and difficulties, all tending to increase the cost. Another important cause of expense is the necessity of keeping both streets and tracks in service during the execution of the work.

Interference with sewers and water mains and changes in street grades involve additional cost, which may be borne in part or wholly by the municipality. Maintaining connections with industries under the altered conditions may also involve heavy cost, which may be borne (or at least shared) by the industries. Where a railway grade crossing has to be eliminated in addition to the street crossings there is a further and material increase in cost.

In considering problems of grade-crossing elimination the solution should be sought on a mutual basis of consideration for the interests of the public, the municipality and the railway. Unfortunately, it is too often a case of antagonism and opposition, the municipality trying to get all the concessions possible and to assume the smallest possible share in the expense, while the railway seeks to head off the demands and to limit the cost of its work. The result may be a compromise not really satisfactory to the city or the company, and involving a certain amount of ill-feeling on both sides.

As an instance, in one case a city endeavored to compel a railway to depress its tracks to such an extent as to require no change in street grades, the entire cost of the work to be imposed upon the railway. The latter opposed this successfully in the courts. The adopted plan included a partial depression of the tracks, elevation of

the streets, and a sharing of the cost. On the other hand, a railway proposed to carry its track elevation across a public square by a bare steel viaduct with open floor. This was opposed by the city, and the adopted plan provided for a water-tight deck and the masking of the steel structure with concrete for the sake of appearance.

With problems of this kind on the increase it is to be hoped that there will be a more general recognition and impartial consideration of the public and private rights.

A Real State Engineer

A merry to-do is likely to arise over the new Wisconsin law which concentrates the whole engineering work of the state government in the hands of one man—a state chief engineer. It is a revolutionary law. It will deprive the highway bureau's engineer, for instance, of his title to independence and will make him a mere subordinate of the chief engineer. Such a state of affairs is subversive of all established practices in state administration—and the same is true of city and national administration. As in many other matters, Wisconsin leads with a piece of radical legislation.

The question is: What is engineering work? Are the topographical survey operations conducted by the state geological survey to be classed as engineering service? Is a state building inspector an engineering employee? Today, nobody knows; even the American Society of Civil Engineers does not know. But we will know in a short time, possibly, when the Wisconsin courts decide on the interpretation of the new law. Of course the intent of the law is obvious—to bring under the control of one technically competent head all such state work as must be performed by engineers. If the topographical surveyor is an engineer, then the chief engineer under the law ought to have jurisdiction over him. Conversely, those state officials and employees who by the Wisconsin court decisions are placed under the chief engineer's jurisdiction will thereby be classed as engineers. This result will be very helpful, since no definition of "engineer" has been formulated hitherto. But the wonder of it—that Wisconsin law courts should give instruction to the American Society of Civil Engineers.

One Field That Is Booming

The world has always spent a good deal of money in amusing itself, but it is doubtful if ever before there has been a time when this money has so benefited the building constructor as at the present, when, to say the least, new enterprises for construction are not frequent. Whatever may be the prospect for increased construction work in the more practical fields, there seems to be no lack of capital for amusement enterprises.

In this issue of *Engineering News* there are illustrated two large pieces of such engineering work, aggregating in total cost some $3,000,000 and involving not only a fairly intricate design, but a construction made doubly complicated by requirements of exceptional speed. These two—the Sheepshead Bay Speedway and the Boston Ball Park—are but typical of a great quantity of such work under way or recently completed in widely distributed sections of the United States.

Of course every city worthy of the name has its ball park, but most of these mean work only for the local carpenter and builder. In the "big-league" towns, however, the ball park has become a formidable piece of engineering construction, more or less standardized to be sure, but nevertheless requiring careful design and as a rule rapid construction. The same may be said of the ever-increasing number of stadiums, without which nowadays no university can properly instruct youth. To call to mind the enormous piles of concrete at Harvard, Princeton, Chicago, Syracuse, College of the City of New York, to say nothing of the municipal stadiums at San Diego and Tacoma, can but emphasize the great number of dollars invested in property which has brought nothing but, to quote the economist, "psychical wealth" to the world.

The motor speedway is a more modern development, but is a natural growth from the horse racing and later cycle track, with the additional requirements of size to care for attendance running up toward 100,000 and of strength imposed by the high-powered and high-speed automobile. Engineering talent is required in the design and layout of such tracks and constructive ability of a high sort in their quick erection. The Sheepshead Bay track is the largest of the lot, but similar tracks in Philadelphia, Providence, Louisville, Chicago and St. Paul are under way. At another time attention will be called to some of the problems of design in such tracks and particularly to the great variation in the surfacing used on the tracks so far built. Meanwhile, it is pleasant to note that the engineer and contractor are getting a part, though only a small part, of the vast sums of money spent by the American people in recreation.

Busy days are in prospect for engineers who go to San Francisco to attend the numerous conventions of technical societies which are to be held there in September and October. Only a few of these societies have as yet sent out their programs for the convenience of those who wish to plan their time in advance. Under "Society Proceedings," elsewhere in this issue, will be found a synopsis of the program of the International Engineering Congress, prepared from an advance typewritten copy.

Without disclosing any secrets, it may be stated with certainty that the program, entertainment and exhibit committees of the New England Water-Works Association have done their part toward making the convention which is to be held in New York from Sept. 7 to 9 a success. The membership at large may be counted on to do the rest. The convention will meet a day earlier in the week than usual, for the convenience of members who wish to take the Engineering Congress train for San Francisco on Sept. 10.

For the second time in two years the conventions of the American Public Health Association and the New England Water-Works Association clash. This seems to be a shortsighted policy in view of the members and officials common to both organizations. It seems as though a conflict of dates might be easily prevented in the future if only some attention were given to the matter by those having the interests of each association at heart. It may be added that the convention of the American Public Health Association at Rochester on Sept. 7 to 10 promises to be a good one. This makes it all the more a pity that the two conventions come on the same days.

Letters to the Editor

How Engineers Earn Fees

Sir—The writer noticed an article recently in one of the road journals entitled "Has the Contractor a Snap?" This article set forth items of contingent cost that are generally overlooked by contractors. It occurred to me that the contractor is not alone in being misunderstood for few people outside the engineering profession realize what the engineer has to contend with, especially in municipal work. In my practice I have continually been told that engineers earn their money only too easily. I am therefore prompted to write this letter to you.

The question "Has the Engineer a Snap?" may be answered perhaps better after itemizing the expense and trouble which the engineer must undergo, some of which are as follows:

1. Expense of looking over the proposed work and closing the contract for employment.
2. Expense of making necessary investigations and surveys.
3. Expense of getting out report.
4. Expense of traveling and time in submitting report.
5. Expense of time in convincing clients and local "home-grown" or "native" engineers that the report, plans and specifications are correct, or rather *trying* to convince them.
6. Expense of defending plans, specifications and ideas against the "butting-in" engineer.
7. Expense of assisting clients to carry on a campaign of education against the onslaughts of the public.
8. Expense of getting out the final working plans, specifications and estimates.
9. Expense of attending letting for construction work and for purchasing of materials, machinery, etc., and assisting clients in getting *legal* contracts closed up.
10. Expense caused by having to defend plans and specifications against the "salesman-engineer," who has something to sell, and promoters of "blue-sky" schemes, who pose as public benefactors and do everything that they possibly can to have the specifications drawn so that competition is eliminated. (These same fellows are always the first ones to howl if the specification is closed against their particular article, and I have noticed that their particular article is always the best.)
11. Expense of time in examining forms or bonds to be furnished by the contractors.
12. Expense of time in approving manufacturer's plans of machinery, details, etc.
13. Expense of time in getting contractor started on his work.
14. Expense of starting resident engineer out on the work.
15. Expense in straightening a hundred trivial matters as the work progresses. (The resident engineer can handle the situation, but clients always want the "main guy" on the ground in person.)
16. Expense of making final inspection and test of the work.
17. Expense of getting out complete record, plans and maps.
18. Expense of time in getting plant running in good shape.
19. Expense of time in getting what is coming to one of the "balance due."
20. Expense of taking a vacation to recuperate and nurse oneself back to health.

W. L. BENHAM.

Oklahoma City, Okla., July 26, 1915.

Engineering Students Should Practice Public Speaking

Sir—There have been several interesting articles of late in *Engineering News* regarding the status of the engineer and why as a professional man he does not hold the positions he should relative to the other professions. I think Mr. Benham, of Oklahoma City, Okla., struck the keynote in his article, "Engineering Students Should Practice Public Speaking," in the issue of July 15, 1915.

Nearly everyone will admit that no profession renders greater service to mankind than the engineering profession, not only materially, but in the comforts and conveniences it brings and in the impetus it gives to better things—to religion, culture and philosophy. These questions then naturally arise: Why does the engineer not enjoy the prestige other professional men do? Why does he not receive the credit due him for the service he renders? Why is he not a properly balanced man?

And the reason? The engineer does not receive enough publicity. He is too unassuming. He does not "mix." He does not assert himself and his deeds enough. In fact he requires a publicity agent; and he must needs be his own, for no one else is willing to fill this office for him. In the apt words of the young philosopher: "He who tooteth not his own horn the same shall not be tooted."

The fault lies, it seems to me, in our colleges and schools where the future engineers receive their training, although it is being remedied at present in some instances. In the university the engineering students constitute the hardest working, most self-centered and self-contained group. (And no doubt the engineer educated in the university is broader than his brother of the technical school, or at least he should be.) They have few interests outside their own studies, which occupy nearly all their time. They are not good "mixers" as a rule. They take no part in literary societies or public exercises of any sort. They are quiet, hard-working, unassuming, and therefore little known among the student body. And do not these characteristics prevail among the older engineers of your acquaintance who are practicing their profession? The fault must lie, then, in their early training.

Where is the remedy? It, too, lies in our colleges and schools. There should be literary societies, public speaking or entertainments of some kind that would place the student before the public or before an audience and give

him valuable training as well as valuable advertising. This is an age of advertising, and the engineer must "get into the game" and advertise himself.

I heard a prominent highway official of this state say not long ago that the art of public speaking was one of the most important attainments of the engineer of today. This official is an able speaker himself, and he owes his success largely to his ability to talk to an audience entertainingly on technical subjects.

It behooves our schools of today to prepare the engineer of tomorrow for elevation to the position he deserves to hold among the other professionals.

J. S. MILLER.

Wharncliffe, W. Va., July 31, 1915.

Danger in Vessel Operation

Sir—The capsize of the "Eastland" has revealed to the public an amazing disregard of public safety in connection with the stability of vessels and has given rise to a general public demand for a more efficient inspection of passenger transport by water than that now existing. With reference to this, two personal experiences of the writer may be worth putting on record.

In 1892 while living in Chicago I went on several excursions between Chicago and Michigan City by the exact route, I believe, which was to have been followed by the "Eastland" on the day when it came to its disastrous end. The boats I traveled on in those days were so unstable that the stability of the craft was maintained by a rolling ballast operated as follows: On the lowest deck there were about twenty heavy barrels, specially hooped and containing lead for weight. Against the center post in the lower deck was suspended a wooden pendulum about 10 ft. long. A foreman sat on a box and watched the pendulum, and as the dear people were enjoying themselves and moving from one side of the ship to the other on the upper decks, he would swear and yell at his men to roll the barrels to the side necessary to trim the boat, as indicated by the motion of the pendulum. Just what "formula" was used to make the travelers safe I never knew, and I doubt very much whether in any other country in the world such trifling with danger would be permitted.

Another trip I once made was from Seattle to San Francisco on a steamer whose name as I now remember it was "The Queen." She was a beautifully painted vessel with a lot of woodwork above her water line and the usual big steel smoke-stacks coming up through the decks. Shortly before beginning this trip "The Queen" had lost one of her propeller blades, and the chief engineer told me, in explaining why he was running the engines at such high speed, that the captain had determined that he would take his 300 passengers into San Francisco on time by using forced draft to make up for the loss of efficiency resulting from the missing blade. In consequence of this forced draft, the smoke-stacks were so hot all the time that we enjoyed the spectacle of laborers sitting on each deck playing a hose on the woodwork around the stacks for 2½ days during the entire trip to San Francisco. We reached there on time and of course hugely enjoyed the extraordinary provisions for our safety and comfort.

I doubt very much, however, whether similar laxness would be permitted in any other country in the world. With you and all other good citizens I hope some day for the existence of a nonpolitical, practical and highly scientific vessel-inspection system in the United States that will protect our country from such disgraceful occurrences as the appalling "Eastland" disaster.

C. L. H.

New York, July 31, 1915.

Give the Experienced Engineer a Chance in Highway Work

Sir—If city and state highway departments would or could employ experienced engineers instead of young college men with little or no practical experience thousands of dollars would be saved the public on work the cost of which annually mounts into millions of dollars.

One doesn't find a young and inexperienced physician acting as head surgeon in a big hospital, nor a young law student acting as counsel of a big corporation, but to see an inexperienced young college man directing the expenditure of thousands of dollars on public road work is common.

It is very easy to waste money in highway work on account of poor location, a branch of engineering which requires long and thorough experience both in preliminary and construction work. The inexperienced man in nine cases out of ten takes the easiest route known to the general public, simply because he has little or no confidence in himself and fears the result of a mistake. On the other hand, I know many old railway locating engineers who are out of employment at the present time because of poor business conditions throughout the country—men who have successfully located miles and miles of railroads in the United States, yet today they would be glad to make $75 per month.

Our engineering societies ought to make some protest over this condition of affairs. Are those men who have met with success in engineering and whose employment would save the public many thousands of dollars to be allowed to sit idle, or should they and the public be given a helping hand?

The great trouble in getting men for highway work is generally that a man must travel several miles to a large city to take a written examination, and in a written examination the younger college men will beat the experienced engineer every time. It often happens in the Central West that a big university is turning out men in the very city where the Chief Highway Engineer is located and that these students get in on the ground floor when it comes to filling up the Highway Department staff.

There should be a system similar to that which the great railroad companies have of hiring men on their record of past experience. I do not want college students to misconstrue my meaning in writing this letter, for although it looks as though I was down on the college man, this is far from true. The college man is the best man without a doubt, but he should start from the bottom of the ladder and work up, the same as others have, as far back as I can remember, until this state highway work started up.

A. R. MIELLY.

New Orleans, La., Aug. 7, 1915.

The Mineral Production of Alaska to the close of 1914 is estimated at $268,150,000, of which $244,000,000 was gold. The territory's mineral production in 1914 was valued at $15,764,000 and included about 21,500,000 lb. of copper.

National League Ball Park at Boston, Mass.

SYNOPSIS—The largest ball park in the country. Seats 40,000 people. Built in five months. Reinforced-concrete stands, fence and club house. Nearly 100,000 cu.yd. of grading required.

The Boston National League Base Ball Club opened on Aug. 18 its new park in the Allston district, only 15 min. by street car from the business center of Boston. The park is located on a tract of land which up to last spring was a golf club, situated between Commonwealth Ave. on the south and the tracks of the Boston & Albany R.R. on the north, with the Charles River beyond. The site was not turned over to the contractor until Mar. 20 of this year, and the opening game in the practically completed park was held on Aug. 18. This remarkably fast contract work comprised the excavation and transfer from cut to fill of about 100,000 cu.yd. of earth, the placing of a number of piles under the footings of the stands, the erection of stands capable of seating 40,000 people, the construction of a large club house and a reinforced-concrete fence entirely surrounding the grounds, and the leveling of a parking space outside of the grounds where automobiles and street cars can stand during the game.

Fig. 4 shows the general layout of the park and Fig. 1 is a view of the grounds looking north across them, taken about the first of April, just as work commenced. It will be seen that there existed on the golf course a sizable pond which had to be filled in at the beginning of the work. The ground was rolling, and steam-shovel excavation consisted in leveling up the playing field, in filling the pond, and in excavating for the lower part of some of the stands, the fill being taken by horse and wagon to make the slope in the upper part of the stand. This operation resulted in the level of the playing field being nearly 20 ft. lower than the level of the concourse back of the stand, and also it required the lower part of some of the stands to be built directly on the ground, as shown in Fig. 5, while the upper parts are built on the customary columns.

The distinguishing feature of the field from the lay viewpoint is its extreme size. As may be noted in Fig. 4,

FIG. 2. BOSTON "BRAVES" BALL PARK ON JUNE 23, 1915, AFTER THREE MONTHS'

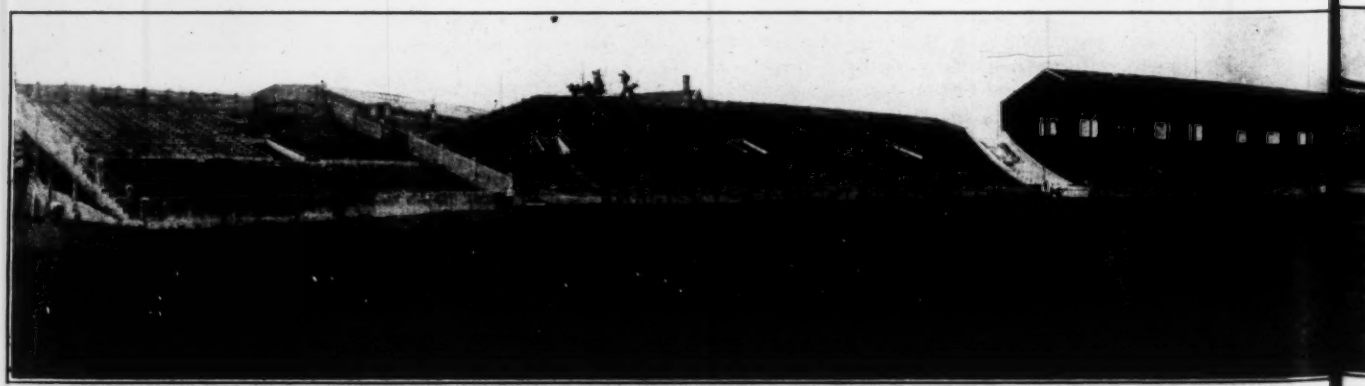
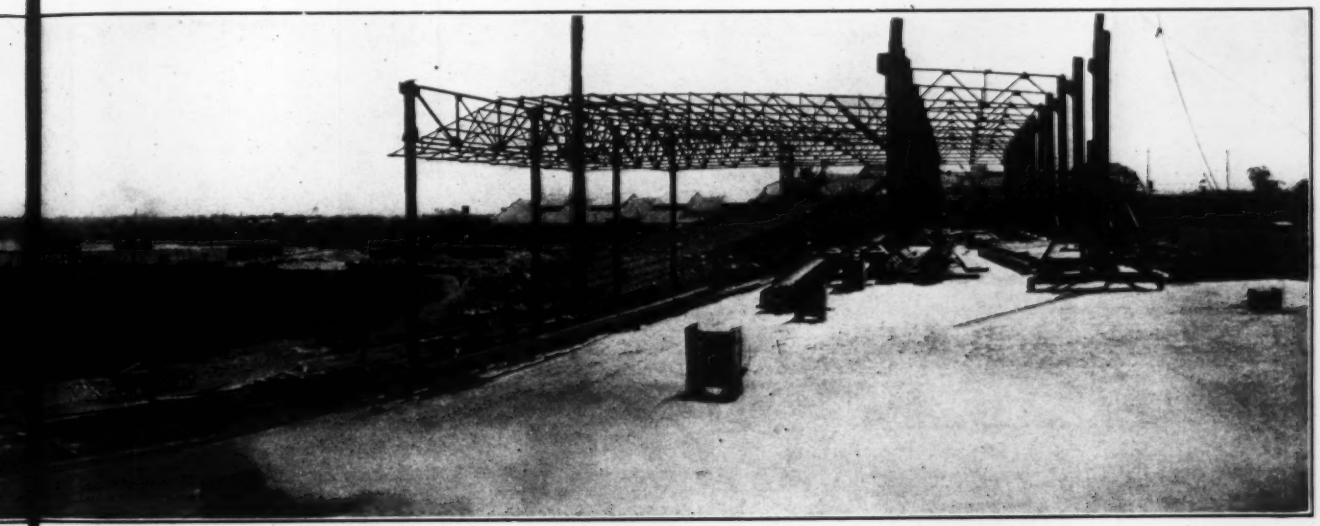


FIG. 3. LOOKING OVER THE PLAYING FIELD TOWARD THE STANDS, AUG. 16, 1915, TWO

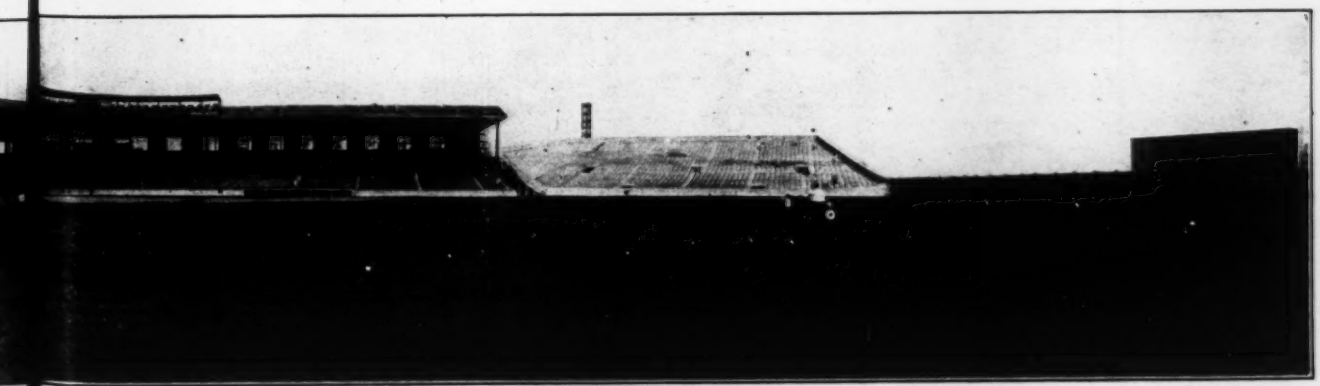
the home plate is 350 ft. distant along the foul line from the nearest point on the stand, while the bleachers and the far side of the pavilions are so far distant from the diamond as to remove all danger of batting a fair ball into a stand. The total area of the inclosure is 15 acres.

Three types of structure were used in the stands—the grandstand, the pavilions and the bleachers, graded according to price of admission. These were laid out in circular plan as shown in Fig. 4. A detail of a section through the grandstand is shown in Fig. 5. The ground

FIG. 1. SITE OF BALL PARK ON APR. 1, 1915, ABOUT A WEEK AFTER WORK COMMENCED



WORK. GRANDSTAND CONCRETE COMPLETED, PAVILION CONCRETE BEING LAID



DAYS BEFORE THE OPENING OF THE PARK. TWENTY WEEKS FROM FIG. 1 TO FIG. 3

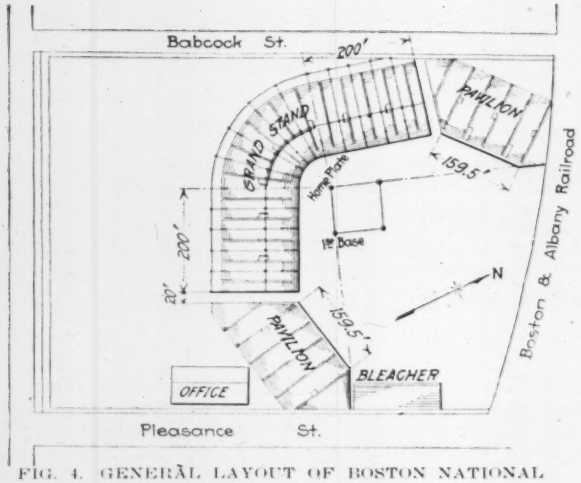


FIG. 4. GENERAL LAYOUT OF BOSTON NATIONAL LEAGUE BALL PARK

on which the grandstand was built is partly in cut and partly in fill, though the fill is not shown in the particular section drawn in the figure.

The slope of the stands is designed to afford a good view of the diamond from every point. The lower steps, in front of the boxes, have a 3-ft. tread and 3-in. rise, and the main steps increase in rise from 5½ in. at the bottom to 10½ in. at the top, with a uniform tread of 2½ ft. The seats themselves rest on concrete steps in the lower part laid directly on the ground and reinforced along the bottom with a plane of wire mesh. Above the ground the steps are of the same relative slope and size, but are of reinforced concrete, of the design shown in Fig. 5, resting on stringers, which in turn rest on columns spaced 20 ft. transversely and 10 to 17 ft. longitudinally, according to the requirements of the layout.

The columns and stringers are of structural-steel members framed together at the junctures and incased with concrete, according to the details shown in Fig. 5. At the

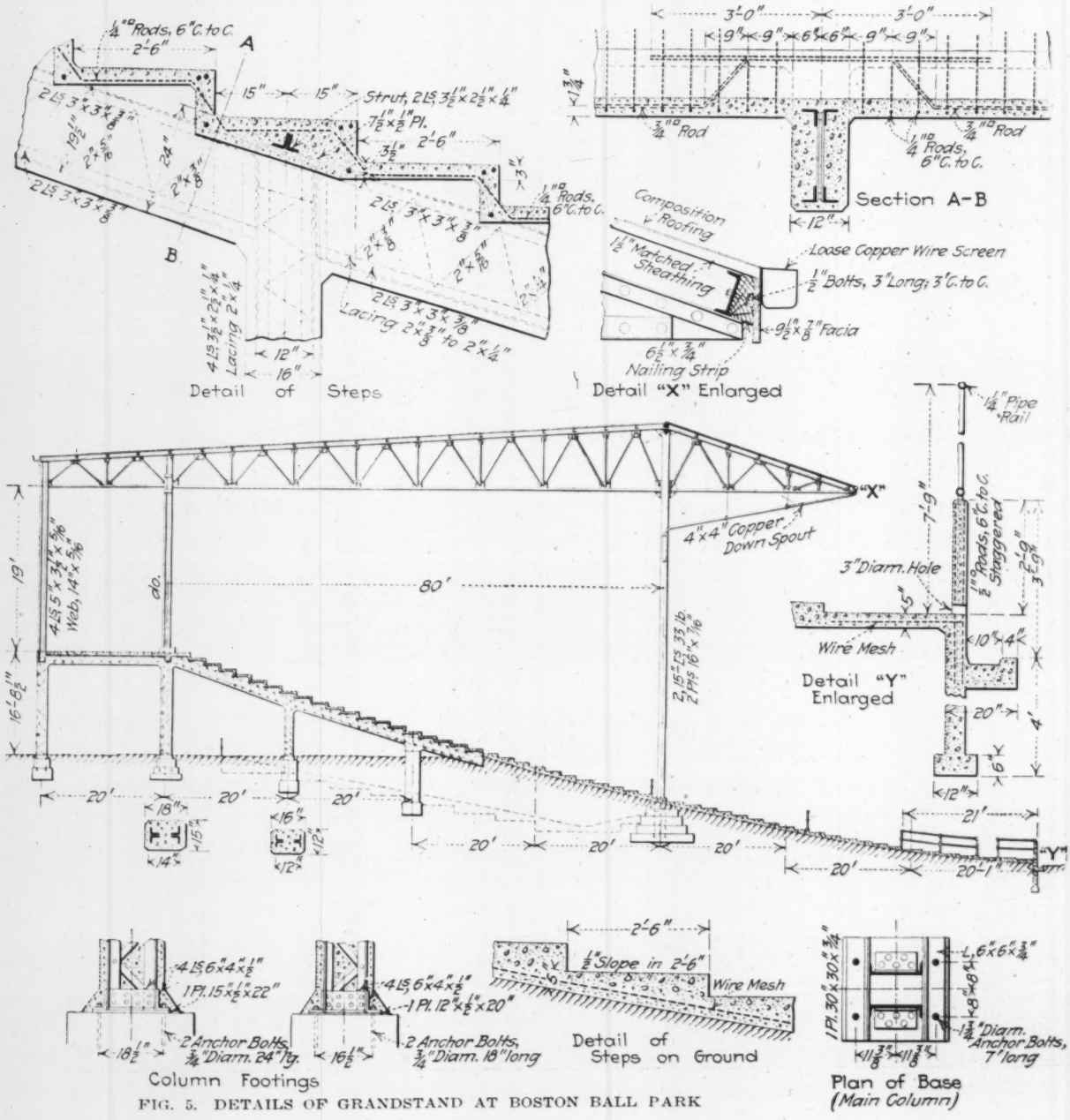


FIG. 5. DETAILS OF GRANDSTAND AT BOSTON BALL PARK

rear bay of the span the structural steel of the concrete and steel columns is extended up to form the columns for the grandstand roof, which extends forward and is carried on columns rising directly from footings near the forward end of the stand. The rear columns are connected by hollow-tile plastered to form curtain walls. The stands are separated from the field by a reinforced-concrete fence shown in Fig. 5. In the grandstand the seats are of the folding individual type, bolted down to the concrete steps.

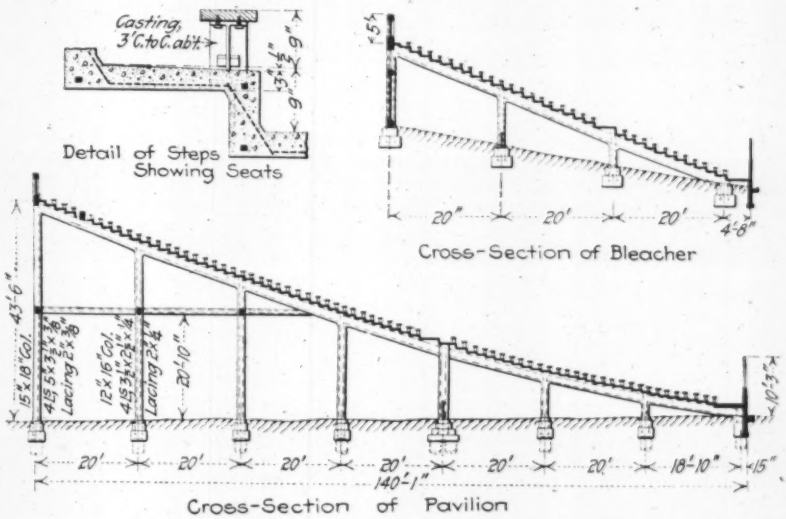


FIG. 6. PAVILIONS AND BLEACHER SECTIONS

The pavilions and bleachers are of the general section shown in Fig. 6 and of structural detail corresponding to the typical detail given in Fig. 5. The difference between these stands and the grandstand is that there is no cover, and that instead of folding seats there are benches screwed down to permanent cast-iron standards. The framing details are the same as in the grandstand, except where space required cross-bracing girders to stiffen the columns. All stands are approached by ramps through the structure and up to the rear promenade. The boxes at the front of the grandstand are entered from downward-sloping inclines, as shown by dotted lines in Fig. 5.

All the columns under the grandstand and pavilion B were founded on concrete piles of the "pedestal" type, driven by the MacArthur Concrete Pile & Foundation Co. For these footings 305 piles, of an average length of 20 ft., were driven singly or in groups of from two to thirteen per footing. The soil consisted of the loam fill, brought in most cases from the remainder of the field and underlain with sand and gravel. Piling was especially required over the site of the old pond.

The office and club house at the entrance to the field is a three-story building of pleasing design, mainly of reinforced concrete. The fence which surrounds the site is 12 ft. high and has a vertical reinforced-concrete slab between posts spaced every 12 ft., with an expansion joint at every fourth post. At the rear of the playing field the revised ground elevation is so far above the tracks of the Boston & Albany R.R. that a 19-ft. concrete retaining wall was required to protect the tracks, the usual 12-ft. fence being superposed on the wall.

Construction work was naturally carried out by a very large force on account of the short time which was permitted for the work. Steam-shovel excavation into wagons cared for the cut and fill in the first part of the work. Then followed the erection of the steel reinforcing the columns and girders in the upper part of the stand and the direct laying of the concrete steps at the lower part of the seats. As soon as the steelwork was up, the girders were connected with wooden forms and the concrete poured from a high tower and chute which permitted the movement of the chute to any location on a very large section of the stand. There were two such plants and the towers moved from place to place to cover the section under way.

The making of a playing field was one of the first things started in the work. As soon as the leveling-up process was completed subsoil and sodding work was started, so that even before the stands were fairly along the diamond and the outlying parts were well toward completion (Fig. 2). This was necessary so that the field would be in perfect condition by the time the first game was played.

The view in Fig. 3, taken Aug. 16, only two days before the opening game, shows that the park was practically completed in the very short time allowed—less than five months.

The structural design of the stands was in charge of the Osborn Engineering Co., of Cleveland, Ohio, and the construction was carried out by the James E. Gaffney Co., the president of which, James E. Gaffney, is also president of the Boston National League Club. R. G. Collins, Jr., was Engineer of Construction.

More Flood-District Filling in Pittsburgh Begun

Following the extensive flood-filling enterprise carried out by the city of Pittsburgh on the north side (Allegheny) a few years ago, a large piece of filling work on the Pittsburgh side was recently started by M. O'Herron, contractor.

The work is on Duquesne Way and Penn Ave. and the transverse streets from Water St. to 7th or Sandusky St., with some minor work extending as far as 11th St. This territory is to be raised to El. 33.9, the Allegheny filling having been carried up to El. 33.

The work is distinguished by the novel street drainage system adopted. The streets were laid out without longitudinal slope, so that gutters will not perform their ordinary service. Longitudinal 12-in. drains are laid under the street near the curb, receiving branch pipes from street inlets located in the curb about 40 to 60 ft. apart. These special storm sewers discharge into the transverse or main outfall sewers in the cross streets.

Lime Production in 1914—The lime made in the United States in 1914 as reported by the United States Geological Survey amounted to 3,380,928 tons, valued at $13,247,676. The plants operating were reduced from 1023 in 1913 to 954 in 1914. The number of kilns in operation increased from 2338 in 1913 to 2374 in 1914. The most marked feature of the lime industry since 1906 has been the rapid growth in the production of hydrated lime, which in 1913 had increased over 300% in both quantity and value.

News of the Engineering World

Progress on Hetch Hetchy Water-Supply

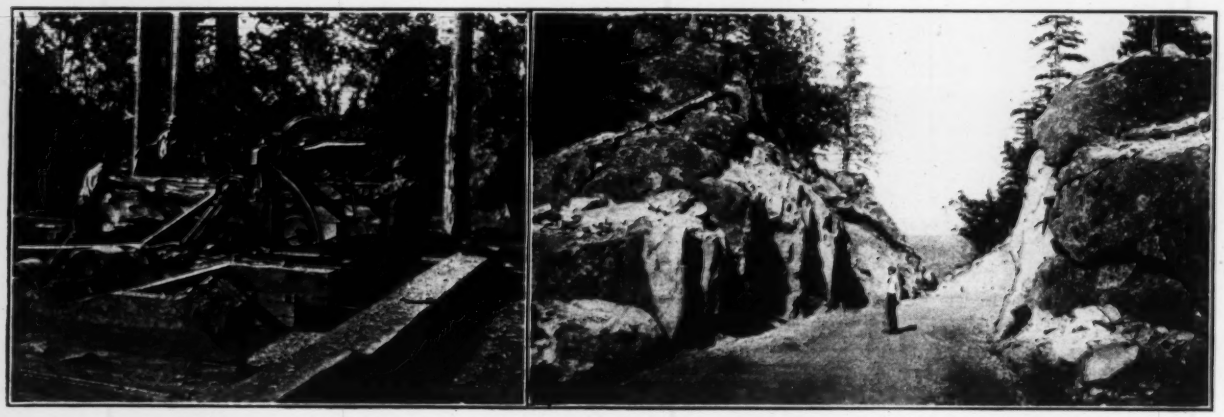
Despite the fact that construction work on the Hetch Hetchy water-supply for San Francisco has been greatly handicapped by lack of funds, as a result of the European War and the consequent stringency of the money market which has prevented the sale of 4½-per cent. municipal bonds, all of the work necessary to comply with the terms of the Raker Act is being rushed by City Engineer O'Shaughnessy, and the great task of bringing Sierra water to San Francisco is well under way.

Work has been started at Early Intake on a tunnel 10½ ft. in diameter, which will be a part of the permanent main aqueduct, and pass through a formation of solid granite for a distance of 20 mi. to a forebay reservoir, and thence to the Moccasin Creek power station. The Early Intake is 12 mi. downstream from Hetch Hetchy Valley, at an elevation of 2320 ft. above sea level. To facilitate the proposed tunnel construction, work is being rushed on a branch wagon road 3 mi. long and 14 ft. wide from Early Intake to the main transportation road, 10 mi. of which has recently been completed by the Utah Construction Co. The Early Intake road runs from the crest of the ridge to the bottom of Tuolumne River cañon, through a particularly rugged country, all of which is in a granite formation. This branch road is now 80 per cent. completed.

San Francisco owns a large amount of timber on Cañon Ranch, an area of 160 acres, between Hog Ranch and Hetch Hetchy Valley. Because of the high cost of lumber in the open market, the city engineer deemed it advisable to erect a sawmill on Cañon Ranch. A contract for the mill equipment was awarded on Apr. 19, 1915, to the Eby Machinery Co. The mill was put in operation on July 30 and will be run continuously. All of the timber for the forms to be used in concrete construction in and near the dam, railroad ties for use in the transportation road, lumber for camp buildings and other purposes will be supplied by this mill.

Work will be begun during August on clearing of timber that portion of the floor of Hetch Hetchy Valley that will be flooded by the construction of the Hetch Hetchy diversion dam. A wagon road has been completed from the bench above the dam site to the floor of the valley. All of the timber cut in the reservoir will be used for tunnel work, railroad ties, poles and forms. On account of the inaccessibility of the valley it would not be profitable to sell any of the wood to outside markets.

A portion of the Hetch Hetchy Valley will be flooded this winter by the construction of a small diversion dam and diversion tunnel to bypass the waters of the Tuolumne River around the main dam while the latter structure is being built next year. That portion of the reservoir which will be under the waters of the lake thus formed will be the first to be cleared of timber.



CONSTRUCTION WORK ON NEW HETCH HETCHY WATER-SUPPLY, SAN FRANCISCO, CALIF.

Left—City sawmill cutting lumber for forms and camp buildings. Right—Cut on new road built by city

A very extensive study was made of the design of a cyclopean concrete dam to be constructed on the Tuolumne River at the lower end of Hetch Hetchy Valley. Every type of arch and gravity section was considered, and a gravity dam, arched as an additional safety factor, was tentatively chosen as the type best adapted to local conditions at the dam site. This dam will be 300 ft. high and will have a crest length of 750 ft. Its cost will be approximately $4,000,000. The design has just been completed by the city engineer.

City Engineer O'Shaughnessy has been exerting strenuous efforts to make an arrangement by which contractors would construct the 67 mi. of railway from Rosasco, on the Sierra R.R., to the Hetch Hetchy dam site this year, and accept 4½ per cent. Hetch Hetchy bonds in payment. Two local representatives of one of the largest contracting firms in America are now in the valley, figuring on this work. The cost of this railway is estimated by the city engineer at approximately $1,850,000. He is hopeful that funds will soon be procured for this purpose.

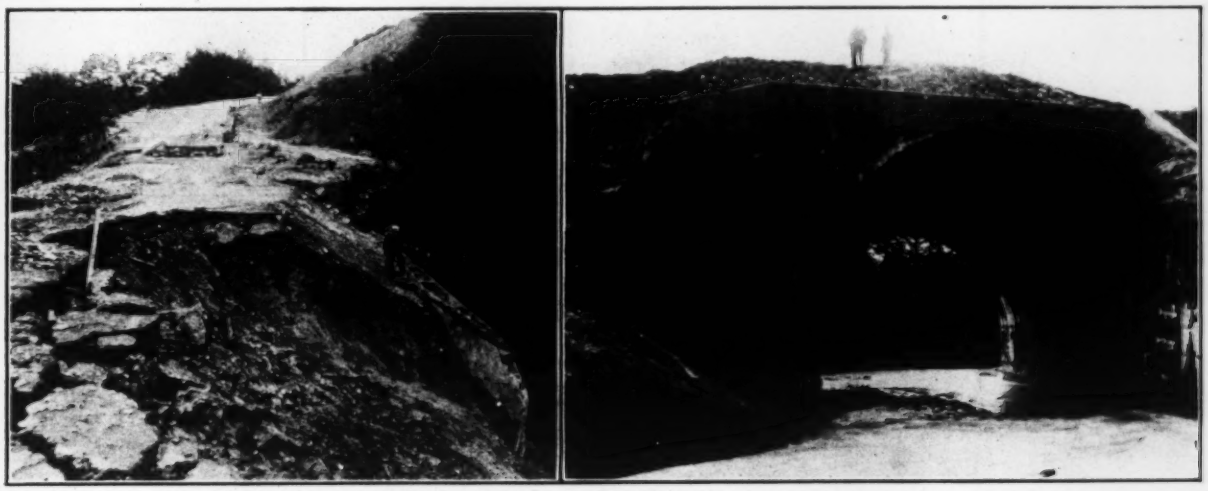
Road and Culvert Washout

The accompanying photographs show a washout on a new fill on the New York State road near Westfield, N. Y., caused by the very heavy rain of Aug. 9. The fill had recently been made over the arch bridge shown in Fig. 2, and was retained mainly by the wings of that bridge. After preliminary gullying the fill was washed out, as shown in Fig. 1, following the failure of one of the wing walls, as shown in Fig. 2.

A State Civil and Mechanical Engineer and Architect

A notable law has just been passed by the Wisconsin legislature and approved by the governor, creating the office of state engineer with a broad range of duties.

The chief engineer is to be appointed by the Railroad Commission and may be removed by the governor upon hearing. This chief engineer has three lines of duty—engineering for all state departments and bureaus, architectural services to the state, and supervision over and improvement of power, heating and similar plants of public institutions.



FIGS. 1 AND 2. WASHOUT ON STATE ROAD NEAR WESTFIELD, N. Y.
The two men are standing at about the same place in each view

Engineering—He is to have charge of all engineering performed by or for the state or any of the departments, boards, or commissions of the state, or in the promotion of any engineering or architectural projects undertaken by the state. He shall furnish engineering services to any branch or department of the state upon requisition. Provision is made for having engineering or architectural work done by contract, in which case, however, the chief engineer shall act with the administrative officers in letting such contracts, and he shall audit claims under it. Where any department, board, etc., requires permanent engineering service the chief engineer will appoint assistants to do such work, to be designated state highway engineer, state architect, university architect, etc., as may be appropriate.

Architectural Service—The duties of the chief engineer as to architectural service are described by exactly the same wording as that defining engineering service. To what extent outside architects will be called in for state work apparently will depend on the future attitude of the heads of state departments and the opinions of the chief engineer combined.

State Power-Plant Supervision—The chief engineer is required to examine and inquire into the matter of operating all state-owned power and electric plants, pumping or heating stations and to direct such changes in the methods or processes employed as will result in the most economical and efficient operation thereof. The superintendents of such plants must keep suitable records as directed by the chief engineer. In his annual report the chief engineer must show in tabular form the cost of operation per unit of product or service of each power or electric plant, heating or pumping station operated by any state institution.

This is the first case of a state creating the office of chief engineer to handle all classes of engineering service for the state, not to speak of architectural service. The importance of the railroad commission is still further increased by the new law. The railroad, utilities, and water-power work of the commission's engineering department presumably will be handled in future merely by one of the departments or branches under the chief engineer.

"Spiral Mushroom" Flat Slab Also an Infringement

As noted in *Engineering News* of June 24, 1915, p. 1245, a perpetual injunction was issued on June 9 against C. A. P. Turner, of Minneapolis, Minn., restraining him from "directly or indirectly making, constructing, using or vending to others to be used . . . reinforced-concrete flooring for buildings, containing or employing the invention described and patented in Norcross letters patent No. 698,542, or any . . . flooring . . . similar to those heretofore constructed . . . by . . . C. A. P. Turner under and in accordance with letters patent Nos. 985,119 and 1,003,384." Subsequent to that the C. A. P. Turner Co. marketed a type of flat-slab construction known as the "spiral mushroom," which was illustrated in

Engineering News of July 15, 1915, p. 144. Under date of Aug. 3, 1915, the United States District Court at Minneapolis decided that this later design came in the same category as Mr. Turner's previous design and that the injunction still held against the later design. The court fined Mr. Turner $200 for violating the injunction.

Train Goes Through a Trestle Just Weakened by a Blow

An unusual railway accident occurred on a trestle at Rainier, Wash., on the Gray's Harbor branch of the Chicago, Milwaukee & St. Paul R.R., in which three persons were killed and sixteen injured, as noted in *Engineering News*, July 15. Just before the Milwaukee passenger train appeared, a freight passed under the trestle on the tracks of the Northern Pacific Ry. A crane arm carried on a car of the freight train worked loose, and swinging out caught a diagonal cross-stringer of the trestle, tearing out a bent. Although an attempt was made to flag the passenger train, it was impossible to stop it before it reached the trestle. The wreckage is shown in the three accompanying photographs, furnished by J. R. West, Chief Engineer, Port of Seattle, who with his family was traveling in the parlor car of the passenger train. Of the three cars this was the only one that remained on the trestle.

The cause of the trouble was the insecure roping of the crane on the freight car. This was done by an inexperienced employee of the construction company owning the crane. The Northern Pacific Ry. did not inspect this car and crane. George F. Yantis, prosecutor of Thurston County, Washington, stated in his formal findings that "while there is some evidence of negligence on the part of the Northern Pacific agents in receiving and moving the car on which was the crane, it does not seem that the negligence was of such nature as should render the agents criminally liable under our law."

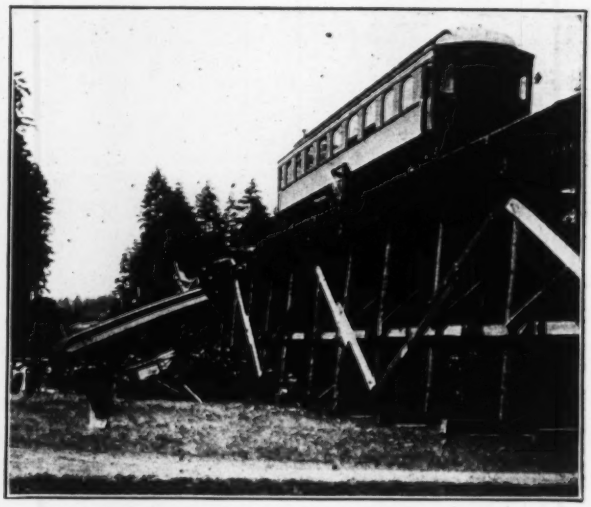
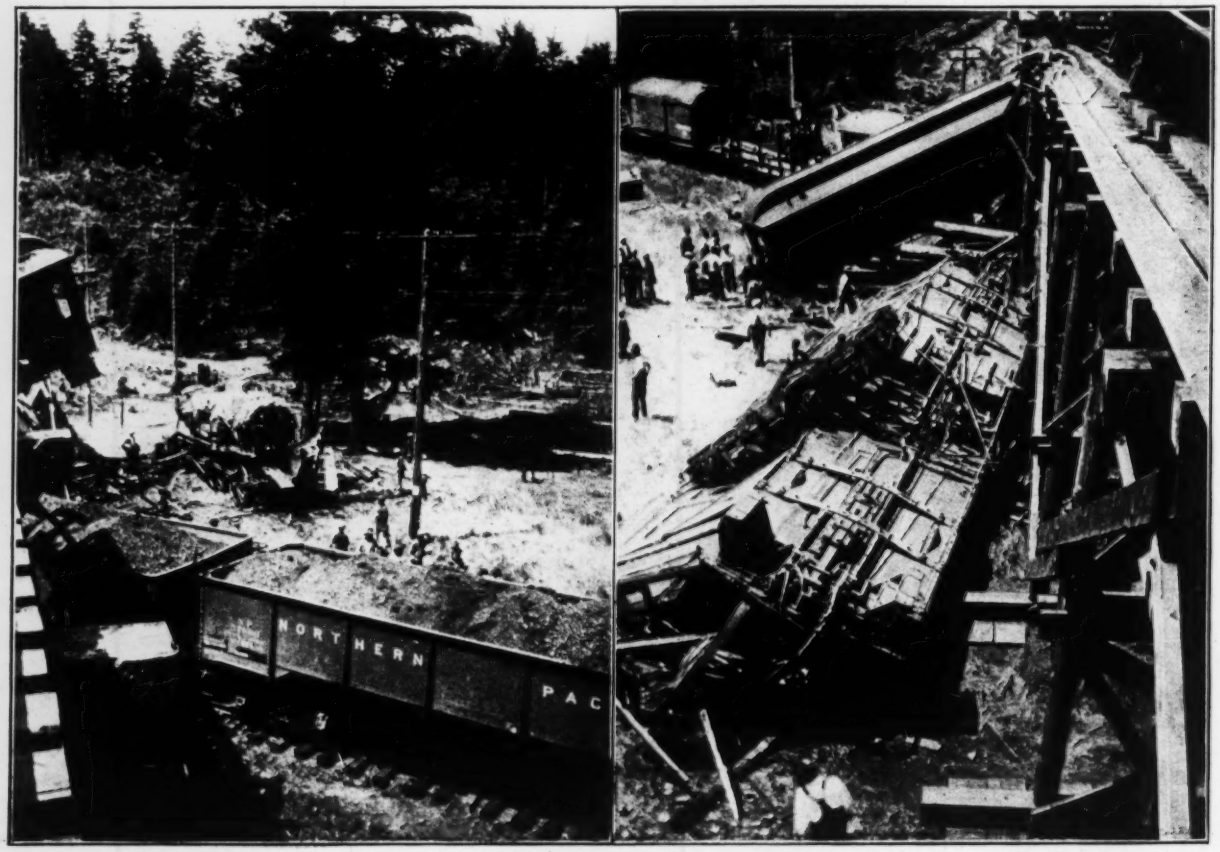


FIG. 3. PARLOR CAR LEFT ON TRESTLE; DAY COACH SMASHED; SMOKER PROPPED AGAINST TRESTLE



FIGS. 1 AND 2. VIEWS OF THE WRECKAGE

Fig. 1—View from front end of parlor car; shows Northern Pacific train on lower level, locomotive in distance. Fig. 2—Smashed day coach in which 17 of the 18 passengers were badly injured

The office of coroner has been abolished in Thurston County, which of course prevented an inquest. Instead, a justice of the peace took evidence and furnished the prosecutor with a transcript. It was the duty of the prosecutor to file formal findings and these took the place of a coroner's jury verdict.

Commission to Make Plans for New York Harbor

The committee on port and terminal facilities for the City of New York (made up of the Comptroller, the President of the Borough of Manhattan, the President of the Borough of Brooklyn, and the Commissioner of Docks and Ferries) has recommended to the Board of Estimate and Apportionment that a commission be appointed with instructions to investigate thoroughly the problem of dock improvement in the City of New York and to produce a plan for the proper development of that port. The committee further recommended the appointment to that commission of John F. Stevens, the well-known railway engineer and former chief engineer of the Panama Canal; George F. Swain, professor of civil engineering in the Graduate School of Applied Science of Harvard University, and William C. Loree, who retired from the position of general manager of the Baltimore & Ohio Southwestern R.R. about a year ago. The committee states that these men were selected after consideration of about thirty names of engineers and railroad experts.

Messrs. Stevens, Swain and Loree have submitted a statement of their understanding of the work to be done, in which they say:

> We understand the problem is the study of the terminal facilities of New York City and the formulation of some plan which will correlate, simplify and facilitate the methods of collection, storage and distribution of freight in New York City. This problem involves the study of the various railroad and steamship terminals, their relation to business centers, the method of carrying freight through the streets, the interchange of freight between railroad and steamship lines—in general, the entire terminal facilities of the city.

They also submitted a schedule of the cost of organization of the proposed commission, which includes annual salaries of the three commissioners at $15,000 each and a secretary, a field engineer, a transportation engineer, a designing engineer and chief draftsman, and a real-estate expert, each at $5000. Other expenses for engineers, clerks and offices would bring the annual expenditure up to about $125,000 per year. The committee says that the work should take at least two years.

It is understood that the Board of Estimate and Apportionment will approve this scheme on Aug. 26, and that the commission, as suggested, will soon go into effect.

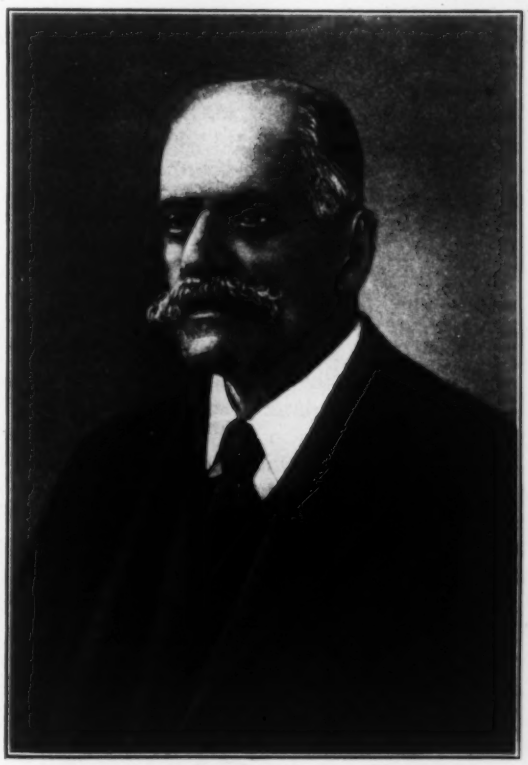
Death of Mendes Cohen

Mendes Cohen, past president of the American Society of Civil Engineers, and prominent in the early days of American railway engineering, died Aug. 13 at his home in Baltimore, Md., aged 84 years.

He was born May 4, 1831, soon after the Baltimore & Ohio R.R., one of the first railways in America, was put into operation. His father was a banker of Baltimore who helped to finance many of the early public works of this country.

The death of Mendes Cohen's father in 1847 resulted in the young man's starting out to earn a living at the age of 16 years. His first work was as apprentice machinist in the Baltimore locomotive works of the famous Ross Winans, builder of many early American locomotives. In 1851, at the age of 20 years, Mr. Cohen was appointed assistant engineer of the Baltimore & Ohio R.R. on work connected with the construction of the Broad Tree Tunnel.

On the completion of this work he was transferred to the motive-power department of the railway. Two important duties were assigned to him during this period—the adaptation of the wood-burning passenger locomotives to coal burning and the handling of traffic on the famous 10-per cent. temporary grade over the Kingwood Tunnel, a remarkable achievement in railway operation.



MENDES COHEN

At 24 years of age he became assistant superintendent of the Hudson River R.R., with which company he remained until 1861, when he succeeded Gen. George B. McClellan as operating head of the Ohio & Mississippi R.R., first being superintendent and later president and superintendent. Shortly after the end of the Civil War Mr. Cohen retired from this position and for a short time was connected with the Philadelphia & Reading Ry.

From 1868 to 1871 he was comptroller and assistant to the president of the Lehigh Coal & Navigation Co. In 1872 he was chosen president of the Pittsburgh & Connellsville R.R., which was subsequently consolidated with the Baltimore & Ohio R.R. system. For many years he was a prominent consulting engineer of Baltimore, and in 1892 was elected president of the American Society of Civil Engineers, of which he had been a member since 1867.

Irrigation in Southern Alberta

Extensive irrigation schemes affecting about 500,000 acres of new land in Southern Alberta are being developed by the irrigation branch of the Canadian Department of the Interior, under the direction of H. Peters, irrigation commissioner. The nucleus of the system now being planned is being opened up this season, covering 30,000 acres in the Taber district east of Lethbridge, which is under development by the Canadian Pacific Ry. The government engineers are now conducting a survey for the extension of this system for a considerable distance east of Taber. The second branch of the new system will include the area lying east of Stirling to Foremost, along the Lethbridge-Weyburn branch of the Canadian Pacific Ry. A third branch will cover the area east of Coutts along the international boundary. It is proposed to furnish the water for these branches of the system through three main arteries tapping the St. Mary's, Belly, Waterton and Milk rivers. As a considerable amount of the Milk River water will be diverted by an American irrigation project, the government engineers are planning to bring water from the Waterton and Belly rivers to make up for that to be thus diverted. An artery from the Milk River, a little to the West of Milk River town, will furnish the supply for the third branch. Survey parties are now in the field making an accurate survey of the course of the river.

Another scheme, the surveys for which have been already made by the government engineers, is known as the Old Man River diversion project, by which it is proposed to irrigate 100,000 acres of the lands to the north of Lethbridge. These various works will not be built and operated by the government, which simply proposes to undertake the necessary surveys so that they may be in readiness when construction is undertaken by local organizations. Under recent legislation adopted by the Alberta government the farmers are authorized to organize irrigation districts, bonding each district for the cost of the system, the farmers paying for the use of the water. This law will apply to all irrigation systems undertaken in the future. While the Old Man River project is likely to be executed in the near future, the construction of the other systems may be deferred for some time until the country to be served by them is more thickly settled.

Street-Railway Tracks in certain Ohio cities may be laid without the consent of abutting property owners, according to a decision of the Ohio Supreme Court on July 20. The decision affirms the right of a city to introduce into its charter a provision permitting street-railway tracks to be built by order of the City Council without obtaining the consent of a majority of the abutting property holders. In the city of Cleveland, certain wealthy property owners along Euclid Ave. between East 22nd and East 40th St. made an agreement years ago to give no consent for the laying of street-car tracks on the avenue unless all property owners joined therein. Under the decision now made by the court of last resort, the city authorities of any city in Ohio having a charter for self-government can rule as to the construction of street-railway extensions.

Disposal of Industrial Wastes—The headquarters for the investigation of methods for the disposal of industrial wastes, now being carried on by the United States Public Health Service, have been moved from Washington to Cincinnati, in order to coöperate with the Ohio River investigation in charge of Passed Asst. Surgeon W. H. Frost, U. S. Public Health Service. The industrial waste studies are under the supervision of Earle B. Phelps, Professor of Chemistry, Hygienic Laboratory, Washington, D. C., with H. B. Hommon in charge of the Cincinnati and field offices. The staff consists of Sanitary Chemist H. C. Colson, Jr., in charge of tests at tannery, Luray, Va.; Sanitary Bacteriologist Walter E. Brown, in charge of tests at strawboard plant, Noblesville, Ind.; Sanitary Engineer H. R. Crohurst; Sanitary Bacteriologists, W. v. D. Tiedeman and Emery J. Thierault, assisting in the studies of industrial wastes on the Ohio River watershed in the vicinity of Cincinnati.

The Kaw Valley Drainage Board will add 4 or 5 ft. to the height of its levees on the Kaw or Kansas River in Kansas City, Kan. This will bring the levee grade to the level of the floors of the highway bridges and to the top of the ties of the railway bridges. The freeboard room thus provided will accommodate a volume of water equal to the estimated entire flow of the river in the flood of June 30, 1903 (300,000 to 350,000 sec.-ft.). The Kansas City Southern Railroad Co. has agreed to raise the level of its bridge at the foot of Ohio Ave., which means a new and longer bridge, estimated to cost $135,000. The only other railroad bridge which is similarly obstructive is that of the Chicago Great Western (used also by the Missouri Pacific) at the mouth of the river. Efforts are being made to get this bridge raised also. The levees will be raised vertically in some places and on the present slope of 2 to 1 in others, widening portions of the top to 40 ft. The dirt will be obtained from the river channel by means of a dredge being built by the drainage board. Estimates of the yardage are now being made. S. H. McNeil is chief engineer and E. B. Murray, of Kansas City, is consulting engineer to the Kaw Valley Drainage Board, whose address is care of Osage & Pyle, Kansas City, Kan.

PERSONALS

Mr. G. E. Byars, recently City Engineer of Waco, Tex., has been appointed Superintendent of Buildings and Grounds of the Agricultural and Mechanical College of Texas at College Station.

Mr. O. P. Hand, former Advertising Manager of the Minneapolis Iron Store Co., of Minneapolis, has been appointed Director of Publicity of the Burd High Compression Ring Co., of Rockford, Ill.

Mr. J. Borge, formerly Chief Engineer of the National Incinerator Co., of New York City, and of Lewis & Kitchen, Chicago and Kansas City, has organized the Borge Incinerator Corporation, with offices in the Flatiron Building, New York City. He has been elected its President.

Mr. Gardner S. Williams, M. Am. Soc. C. E., Consulting Engineer, of Ann Arbor, Mich., has opened an office in Chicago, Ill., for the general practice of engineering specializing in the design, supervision and construction of hydro-electric developments, water-power and water-supply.

Mr. George M. Lehman, M. Am. Soc. C. E., Chief Engineer of the Lake Erie and Ohio River Canal Board, has been appointed by Gov. Martin G. Brumbaugh, of Pennsylvania, to represent the state at the Fifth National Drainage Congress, to be held in San Francisco Sept. 17 to 21, 1915.

Dr William S. Franklin, F. Am. Inst. E. E. resigned as Professor of Physics at Lehigh University, South Bethlehem, Penn. Dr. Franklin has been associated with Lehigh University since 1897, when he went there from Iowa State College as Professor of Physics and Electrical Engineering.

Mr. Morris Knowles, M. Am. Soc. C. E., Consulting Engineer, has acquired the engineering business formerly conducted by the late L. E. Chapin, of Pittsburgh, Penn., and Canton, Ohio. Mr. Knowles was associated with Mr. Chapin from 1902 to 1907. His offices are in the Oliver Building Pittsburgh, Penn.

Mr. A. H. Whiteside has resigned as Sales Manager of the Goulds Manufacturing Co., Seneca Falls, N. Y. The sales department of the company is now divided into two parts, one directed by Mr. R. E. Hall, former Manager of the Boston office, and Mr. W. E. Dickey, former Manager of the New York office, both Vice-Presidents of the company.

Mr. H. H. Henderson, recently representing the Goulds Manufacturing Co., of Seneca Falls, N. Y., in northern West Virginia and southeastern Ohio has been appointed Manager of the company's Pittsburgh office in the Oliver Building. Mr. E. C. Wayne, of the main office at Seneca Falls, has been appointed Assistant Manager of the Pittsburgh office.

Mr. Lorenzo C. Dilks, Assoc. M. Am. Soc. C. E., recently General Manager of Sales of the Eastern Steel Co., New York City, has been elected President and General Manager of Milliken Brothers, Inc., New York City. Mr. Dilks has had many years' experience in the structural steel business with the Pencoyd Iron Works and the American Bridge Co.

Mr. J. H. Staats, M. Am. Soc. C. E., Vice-President and Treasurer of R. P. & J. H. Staats, Engineers and Contractors, has been elected Vice-President of the Snare & Triest Co., Contracting Engineers, also of New York, which has acquired the equipment, plans, records and good-will of the contracting business of R. P. & J. H. Staats. Mr. R. P. Staats, M. Am. Soc. C. E., has retired from active business.

OBITUARY

William B. Dixey, of the Blaw Steel Construction Co., of New York City, died Aug. 11 at his home in Westfield, N. J.

Thomas Bliss Stillman, Chemical Engineer, former Professor of Engineering Chemistry at Stevens Institute of Technology, died recently at his home in Plainfield, N. J. He was born in 1852 and graduated from Rutgers College, New Jersey, in 1873. In 1883 he received the degree of Doctor of Philosophy from Stevens Institute of Technology, with which institution he was connected for many years, retiring in 1909 as Professor of Engineering Chemistry. He was at various times State Inspector of Oils of New Jersey, Examiner in Chemistry of the New York City Municipal Civil Service Commission, City Chemist of Jersey City and Bayonne, N. J., and Chemist of the Medical Milk Commission of Newark. He was a member of many scientific societies and the author of a well-known textbook on engineering chemistry.

ENGINEERING SOCIETIES

COMING MEETINGS

AMERICAN INSTITUTE OF CHEMICAL ENGINEERS.
Aug. 16-18 and 25-28. Annual meeting in Los Angeles, Calif., Aug. 16-18; in San Francisco, Aug. 25-28. Secy., J. C. Olsen, Cooper Union, New York City.

INTERNATIONAL ASSOCIATION OF MUNICIPAL ELECTRICIANS.
Aug. 24-27. Annual convention in Cincinnati. Secy., Clarence R. George, Houston, Tex.

NEW ENGLAND WATER WORKS ASSOCIATION.
Sept. 7-9. Convention in New York City. Secy., Willard Kent, Narragansett Pier, R. I.

TRAVELING ENGINEERS' ASSOCIATION.
Sept. 7-10. Annual meeting in Chicago. Secy., W. O. Thompson, N. Y. C. R.R., East Buffalo, N. Y.

NORTHWESTERN ROAD CONGRESS
Oct. 4-7. At Cedar Rapids, Iowa. Secy., Jas. P. Keenan, Milwaukee, Wis.

AMERICAN SOCIETY OF MUNICIPAL IMPROVEMENTS.
Oct. 12-14. Annual convention at Dayton, Ohio. Secy., Charles Carroll Brown, 702 Wulsin Bldg., Indianapolis, Ind.

San Francisco Meetings

INSTITUTE OF RADIO ENGINEERS.
Sept. 13-18. Secy., David Sarnoff, 71 Broadway, New York.

PAN-AMERICAN ROAD CONGRESS.
Sept. 13-18. Secy., E. L. Powers, Road Builders Association, 150 Nassau St., New York City.

AMERICAN SOCIETY OF CIVIL ENGINEERS.
Sept. 16-18. Secy., Charles Warren Hunt, 220 West 57th St., New York City.

AMERICAN SOCIETY OF MECHANICAL ENGINEERS.
Sept. 16-18. Secy., Calvin W. Rice, 29 West 39th St., New York City.

AMERICAN INSTITUTE OF MINING ENGINEERS.
Sept. 16-18. Secy., Bradley Stoughton, 29 West 39th St., New York City.

AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS.
Sept. 16-18. Secy., F. L. Hutchinson, 29 West 39th St., New York City.

AMERICAN SOCIETY OF HEATING AND VENTILATING ENGINEERS.
Sept. 16-18. Secy., J. J. Blackmore, 29 West 39th St., New York City.

AMERICAN ELECTROCHEMICAL SOCIETY.
Sept. 16-18. Secy., J. W. Richards, Lehigh University, South Bethlehem, Penn.

NATIONAL DRAINAGE CONGRESS.
Sept. 17-21,

INTERNATIONAL IRRIGATION CONGRESS.
Sept. 20. Secy., Arthur Hooker, Sacramento, Calif.; until Aug. 1, New Stockton, Calif.

MINING AND METALLURGICAL SOCIETY OF AMERICA.
Sept. 20. Secy., F. F. Sharpless, 52 Broadway, New York City.

PACIFIC COAST ASSOCIATION OF PORT AUTHORITIES.
Sept. 20 and 21. Secy., Leo V. Merle, Ferry Bldg., San Francisco, Calif.

AMERICAN MINING CONGRESS.
Sept. 20-22. Secy., J. F. Callbreath, Washington, D. C.

INTERNATIONAL ENGINEERING CONGRESS.
Sept. 20-25. W. A. Cattell, Secy., Comm. of Management, Foxcroft Bldg., San Francisco.

INTERNATIONAL ASSOCIATION OF BRIDGE AND STRUCTURAL IRON WORKERS.
Sept. 20-30. Secy., Harry Jones, American Central Life Bldg., Indianapolis, Ind.

AMERICAN SOCIETY OF AGRICULTURAL ENGINEERS.
Sept. 21 and 22. Secy., F. M. White, Madison, Wis.

AMERICAN SOCIETY OF REFRIGERATING ENGINEERS.
Sept. 23 and 24. Secy., W. H. Ross, 154 Nassau St., New York City.

AMERICAN MINE SAFETY ASSOCIATION.
Sept. 23 and 24. Secy., H. M. Wilson, Bureau of Mines, Pittsburgh, Penn.

AMERICAN ASSOCIATION OF REFRIGERATION.
Sept. 23 and 24. Secy., J. F. Nickerson, 431 South Dearborn St., Chicago, Ill.

ILLINOIS GAS ASSOCIATION.
Sept. 27. Adjourned meeting. Secy., H. H. Clark, 72 West Adams St., Chicago, Ill.

SAFETY CONFERENCE.
Sept. 27-30.

INTERNATIONAL GAS CONGRESS.
Sept. 27 to Oct. 1. Secy., George C. Ramsdell, 29 West 39th St., New York City.

AMERICAN GAS INSTITUTE.
Sept. 27 to Oct. 1. Secy., George C. Ramsdell, 29 West 39th St., New York City.

AMERICAN ELECTRIC RAILWAY ASSOCIATION.
Oct. 4-9. Secy., E. B. Burritt, 8 West 40th St., New York City.

AMERICAN ELECTRIC RAILWAY MANUFACTURERS' ASSOCIATION.
Oct. 4-9. Secy., H. G. McConnaughy, 165 Broadway, New York City.

AMERICAN ELECTRIC RAILWAY ENGINEERING ASSOCIATION.
Oct. 4-9. Secy., E. B. Burritt, 8 West 40th St., New York City.

Cleveland Engineering Society—At the meeting of the executive board held on July 3, C. E. Drayer was appointed secretary of the Cleveland Engineering Society. Mr. Drayer is also secretary of the Committee on Engineering Coöperations of the society.

Texas Good Roads Association—Interesting sessions were held at the Aug. 5-6 convention of the Texas Good Roads Association, held at the Agricultural and Mechanical College of Texas. Two of the subjects under discussion were, "Are Special Road Laws Advisable" and "County Convict Labor." James P. Nash read a paper on "Economic Road Materials of Texas." Mrs. March Culmore explained why women favor good roads.

International Engineering Congress—A preliminary program of the International Engineering Congress to be held at San Francisco Sept. 20-25 has been prepared. The printed program will be issued at a later date. Discussions will be held on the following subjects on the days mentioned: General session, Sept. 20; Waterways, Sept. 20-23, mornings; Irrigation, Sept. 23-25, mornings; Municipal Engineering Sept. 21-24, mornings; Railway Engineering, Sept. 21-24, mornings; Materials of Engineering Construction, Sept. 21-23, afternoons; Mechanical Engineering, Sept. 21-24, afternoons; Electrical Engineering, Sept. 22-23, afternoons; Mechanical Engineering, Sept. 21-22, afternoons; Metallurgy, Sept. 21-24, afternoons; Naval Architecture and Marine Engineering, Sept. 21-24, afternoons; Miscellaneous, including Refrigeration, Agriculture, Education, Heating and Ventilating, Sept, 22-24.

Builders' Association of Kansas City—This association was recently formed for the purpose of "promoting and projecting the interests of its members; to maintain just and equitable treatment of their relations with each other and with their employees; to promote steadiness of employment in the building trade; to promote and facilitate the settlement of labor disputes; to prevent strikes, and to encourage the formation of an association of contractors." The officers are: President, James E. Taylor; first vice-president, J. Q. Smithers; second vice-president, E. L. Winn; treasurer, E. L. Marty; secretary, J. A. G. Badorf. On Aug. 5 the property and funds of the Master Builders' Exchange of Kansas City were transferred to the new association. The constitution of the Builders' Association provides for the following standing committees: Ways and means; finances; contracts; legal action and legislation; grievances; membership; promotion and publicity; trade relations. Provision is made for the recall of members and officers.

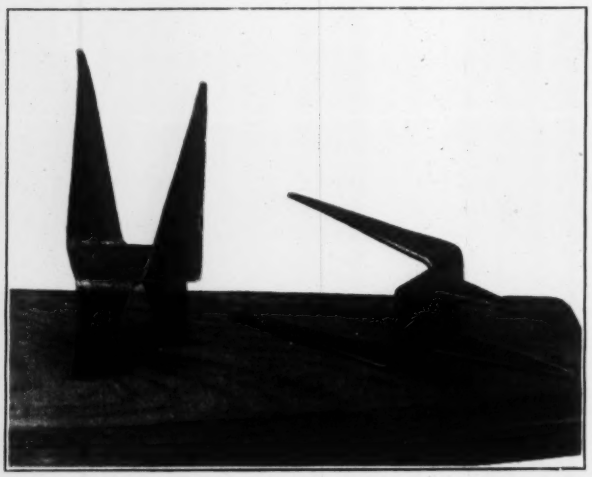
Concrete Road Building Conference—The organization of subcommittees for the Second National Conference on Concrete Road Building, to be held in Chicago, Feb. 15-18, 1916, has been completed. Seventeen committees have been named, each to investigate and submit a report upon a specific topic in

connection with the construction of concrete roads. The committees' subjects are as follows: (1) Drainage and preparation of subgrade; (2) economical widths of pavement and shoulders; (3) problems of design, thickness, crown and grade; (4) aggregates; (5) handling and hauling materials and water supply; (6) organization of concreting crew; (7) proportions of materials and consistency of concrete; (8) mixing and placing concrete; (9) reinforcing; (10) joint location and construction; (11) expansion and contraction; (12) finishing and curing; (13) construction of shoulders and curbs; (14) methods and cost of maintenance; (15) form of specifications; (16) cost of construction; (17) estimating and inspection problems. The Advisory Committee has again elected Dr. W. F. M. Goss, Dean of the College of Engineering of the University of Illinois, chairman and J. P. Beck, secretary.

Appliances and Materials

Chair for Reinforcing Bars

The chair shown in the accompanying view has been designed to support reinforcing bars in the forms during the placing of concrete. It differs somewhat from most devices for the purpose in that it is driven into the forms previous to placing the reinforcement, thereby insuring permanently the correct placing of the steel. Each chair is of heavy sheet steel cut and bent to develop two pairs of sharp prongs. The



REINFORCING-ROD CHAIR

lower pair are driven into the form floor and after the reinforcement has been placed the upper prongs are hammered down to grip the bars. The chairs are being marketed by the Shop-Fabricated Reinforcement Co., 1900 Euclid Ave., Cleveland, Ohio. They have been used recently on several Cleveland buildings. While it was thought by some that there might be difficulty in removing the forms, on account of the grip of the chair, no trouble of this sort has arisen.

• • •

Automatic Wheel-Flange Lubricator

For the lubrication of the wheel flanges of locomotives various automatic lubricators have been devised. One of the latest is the "Detroit Automatic," made by the Detroit Lubricator Co., of Detroit, Mich. The machine consists of an oil tank mounted in any convenient place—usually under the running board, a feed valve, and a delivery nozzle close to the flange. A loose ball in the feeder by impact momentarily opens the control valve. The lift and flow is controlled by spring tension. On switching engines the lubricator body is placed parallel to the boiler, so that shocks of stopping and coupling operate the valve. On road engines the lubricator is at right angles to the boiler and the ball is thrown by rolling on curves, etc. The device can be installed for one or more wheels.

• • •

Contractors' Geared Locomotive

While the Shay geared locomotive in various sizes (up to about 190 tons, noted in "Engineering News," Nov. 26, 1914) has been employed extensively in railway service, its application to construction lines is comparatively new. It has been used, however, on several large contracts for gravel and concrete roads. The engines thus employed are mainly of 13 and 18 tons' weight, the former being used generally for tracks of 24-in. gage. The accompanying illustration shows a 13-ton unit built by the Lima Locomotive Corporation, of Lima, Ohio, for H. W. Reed & Sons, of Mishawaka, Ind.

This type of geared locomotive has vertical cylinders at one side of the firebox, driving a crank axle parallel with the track. The engine is mounted on a pair of four-wheel trucks, and each wheel on the driving side of the engine has a

CONTRACTORS' GEARED LOCOMOTIVE

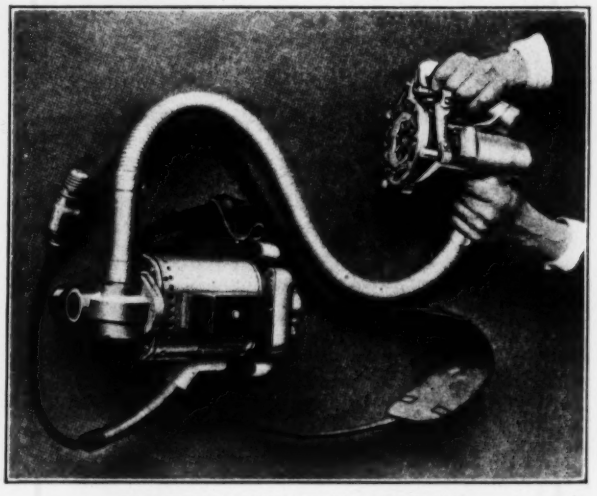
bevel gear bolted to its face. In the truck frame is carried a short shaft with bevel pinions engaging these gears. The truck shafts are connected to the crank axle by intermediate shafts having flexible couplings to allow for the swiveling of the trucks and for vertical irregularities of the track. The 13-ton engine has two 6x10-in. cylinders and 22-in. wheels. The truck wheel base is 4 ft. and the total wheel-base 18 ft. 10 in. The frame which supports the boiler and cylinders supports also the rear bunker, which holds ¾ ton of coal and 400 gal. of water. The maximum tractive effort is 6050 lb.

• • •

Concrete Surfacing Machine

A portable electric-driven tool for removing form marks, pits and irregularities from concrete walls, floors and ceilings has been devised by J. O. Berg and is being made by the Elevator Supply & Repair Co., Willow Ave. and 15th St., Hoboken, N. J. The machine is adapted also to remove metal scale, old paint, etc.

It comprises a small electric motor carried by the operator and a disk tool with 16 hardened-steel rotary chipping wheels



CONCRETE SURFACING MACHINE

driven by a flexible shaft. The entire outfit weighs 30 lb.; the tool alone weighs 9 lb. The motor is for use on both alternating- and direct-current lines of either 110 or 220 volts as desired. The machine is claimed to prepare 100 sq.ft. of wall per hour ready for float finish; 70 sq.ft. per hr. can be cut down to even color, and the aggregate exposed at the rate of 60 sq.ft. per hr. A cost reduction by machine-work of 50 to 75 per cent. below hand-work cost is reported.

Engineering News

VOLUME 74 AUGUST 26, 1915 NUMBER 9

Concrete Dome for the New Technology Buildings

The crowning architectural feature of the new buildings for the Massachusetts Institute of Technology on the banks of the Charles River, Cambridge, Mass., is to be a large dome surmounting the central one of the group, which is located at the extreme inside end of the forecourt leading up from the river. While externally this dome, with its building, will be of limestone in architectural keeping with the rest of the buildings, its structure is of reinforced concrete, the same as the other structures. The view on this page shows a recent stage in the building of the dome, which is now almost completed.

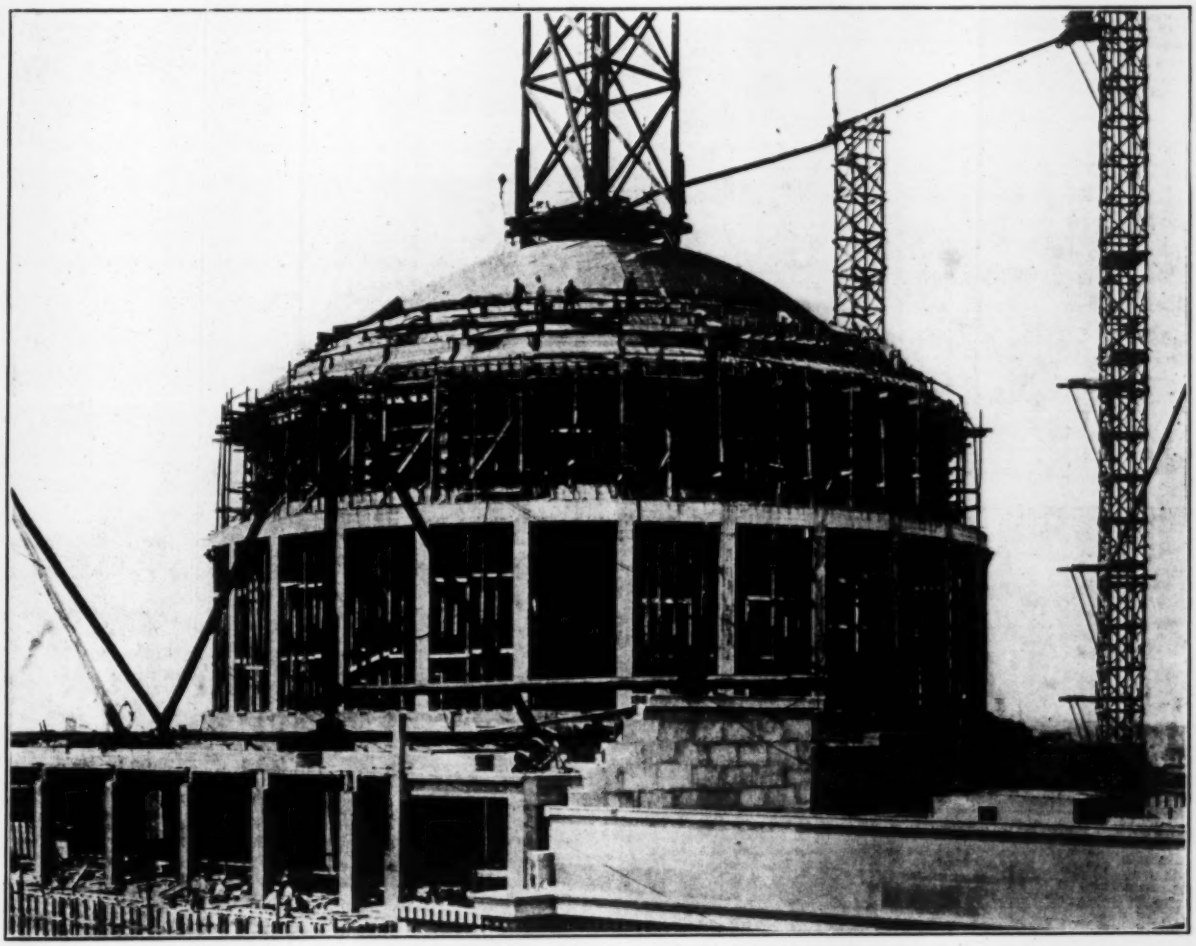


FIG. 1. CONCRETING THE DOME OF NEW TECHNOLOGY BUILDINGS, CAMBRIDGE, MASS.

That portion of it which rises above the five-story reinforced-concrete building upon which it is located consists of two tiers of cylinders, or drums, surmounted by the dome proper, the lower half of which is in the form of steps and the upper half in the form of a truncated sphere the flat top of which has an opening to admit light to the interior. The drums are supported on two circumferential rows of columns, the outside row of the lowest drum resting on a ring girder spanning the beams of the fifth floor of the main building, and the outside row of the upper drum spanning radial beams connecting the outer and inner columns of the lower drum. The inner columns of the two cylinders are continuous through to the building below, being located on the corners of an octagon.

The step portion in the lower half of the dome is of reinforced-concrete slabs formed to step shape and resting on radial inclined girders spanning the outer and

inner columns of the upper drum. The upper part of the dome is a portion of a sphere, and abuts at its lower plane on a ring girder spanning the inner columns of the drums, the upper plane being formed by a ring girder on the rim of the top opening. This slab varies in thickness from 5 in. at the top to 8 in. at the bottom, and is reinforced with a cross-webbing of twisted rods of the type shown in the view, Fig. 3.

The dome is 147½ ft. above the general level and 65 ft. above the parapets of surrounding buildings. The diameter of the lower cylinder is 120 ft. and its height 37 ft. The diameter of the upper cylinder is 108 ft. and its height 18 ft. The spherical portion of the dome, including the steps, is 23½ ft. above the top of the upper drum and is curved to a radius of 56½ ft. The two hemispherical dome portions are 70 ft. in diameter.

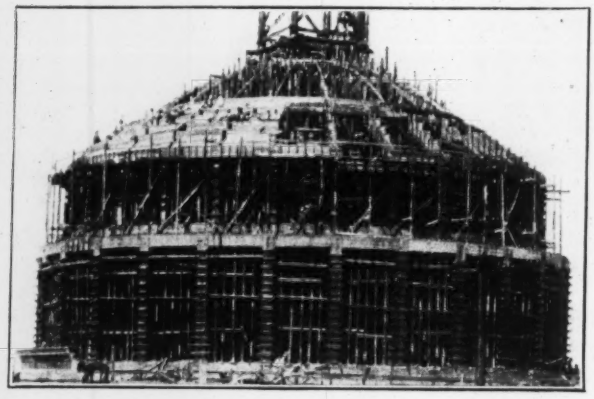


FIG. 2. FORMWORK ON TECHNOLOGY DOME

The view in Fig. 2 shows an earlier stage in the formwork and illustrates fairly well how the dome was carried up. The main framework presented no particular difficulties, inasmuch as it could all be supported from the ring girders, but the central spherical dome had to be supported from the roof of the main building, which required

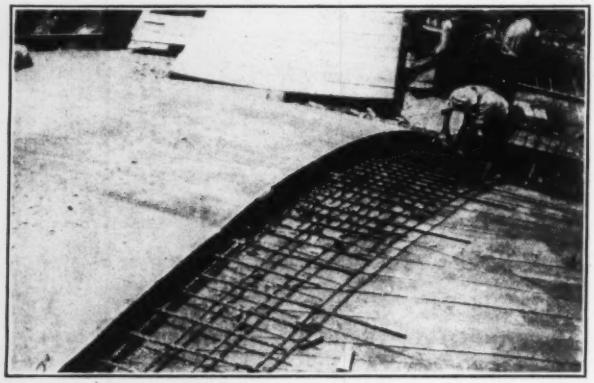


FIG. 3. NEAR VIEW OF REINFORCEMENT IN PLACE ON DOME

thoroughly cross-braced falsework posts from 50 to 70 ft. high. The lower side of this base form for the roof of the dome was made in a continuous operation, forming, in fact, a complete timber dome, as shown in Fig. 2. On this the reinforcement was laid above the step portion while the step portion was poured against vertical forms, the tread of the steps being screeded. This lower section is shown to the right in the dome in Fig. 1. The upper forms for the spherical portion of the dome were laid in the form of small panels of varying shapes to accommodate them to the radius of the dome, 21 of these being used at a time. When the group of forms had been placed, the segment was poured all at once and the operation repeated on the next segment; six segments were required to complete the dome.

Concreting was done from a tower 190 ft. high, located about 100 ft. away from the dome center, the chute being supported, as shown in Fig. 1, by an intermediate tower located on the dome proper. The central tower shown in the views is a continuous timber tower 18 ft. square and 119 ft. high, built up from the roof of the main building. To each corner of this tower is attached a boom, which is used for the conveying of forms and the limestone covering which is now being placed on the dome.

The buildings of the Massachusetts Institute of Technology are being built by the Stone & Webster Engineering Corporation, 147 Milk St., Boston, which firm is in charge of the engineering design as well as the construction. William Welles Bosworth, of New York, is the architect.

The Largest Tunnel in the World

The largest tunnel ever undertaken is that which has been partly driven at Marseilles, France, for the Marseilles-Rhône Canal. The tunnel is 72 ft. wide and the height from the bottom of the tunnel to the crown of the arch is about 40 ft. The total length when completed will be about four miles, and when its great cross-section is taken into consideration in connection with its length, the total volume of excavation will doubtless be greater than that of any tunnel for traffic purposes ever constructed. The total amount to be excavated is in the neighborhood of 2,500,000 cu.yd. E. L. Corthell, in the course of a visit to notable engineering works in the Mediterranean countries, examined this tunnel two years ago and gives a brief description of it in *Professional Memoirs of the Corps of Engineers* for May-June, 1915.

The accompanying drawings show cross-sections of the tunnel and the general method of construction, with a map of the navigation scheme of which the tunnel forms a part. A part of Mr. Corthell's description of the work is as follows:

We arrived at Marseilles on Feb. 22, 1915. Mr. Batard, Chief Engineer of the Port, and Mr. Bourgougnon, Chief Engineer of the Marseilles-Rhône Canal now under construction, were on the dock to meet us and take us first in Mr. Batard's sea-going launch about 5 mi. (8 km.) along the route of the new canal, the terminus of which is in the port of Marseilles, straight to the entrance of the tunnel now under construction through the rocky ridge that separates the Bay of Marseilles from the "Etang de Bolmon," and thence along the shores of the large "Etang de Berre," about 8 mi. (12.8 km.) in all, and thence along the outlet of these lakes to the "Golfe de Foz," along the northern shore of that water direct to ancient Arles, following the latter part of the way the course of the Rhône.

The total length, Port of Marseilles to the Rhône at Arles, is somewhat less than 50 mi. (80.5 km.). It is built to bring the Rhône River traffic from Lyons and above direct to Marseilles. It is being built by the French government, with some assistance from the Chamber of Commerce of Marseilles. The large Rhône barges can then avoid the dangerous route of 25 mi. (40.2 km.) around Cape Couronne from the mouth of the Rhône, or rather from the mouth of the St. Louis Canal to Marseilles.

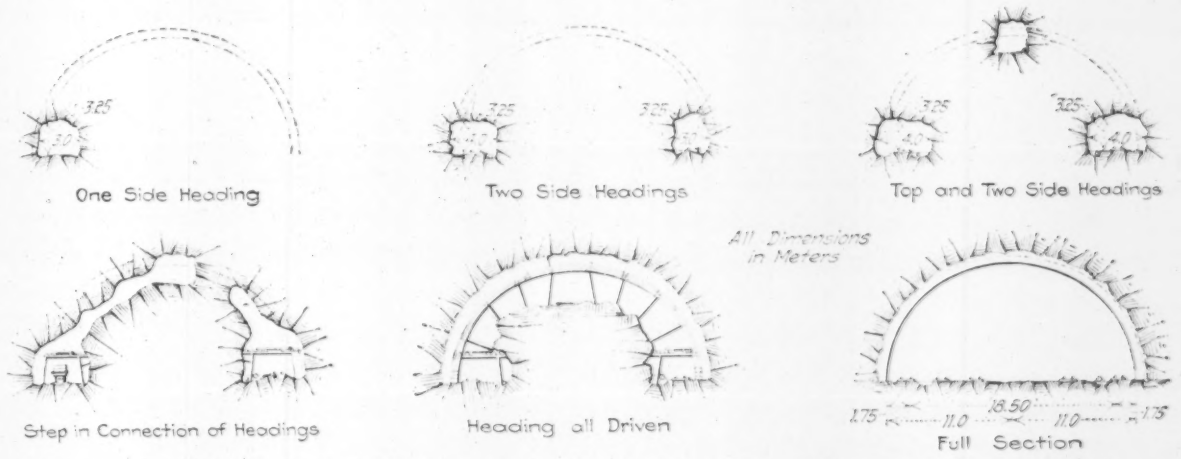
Before describing the tunnel, which is the principal feature of interest, let me say that the mouth of the Rhône has an interesting history. For centuries the question of improving it for the Rhône navigation had been a matter of study, projects and efforts, until the government started to build dikes to close the smaller outlets of the delta and two jetties at the principal mouth. But two serious errors were made, the jetties were too far apart and the methods of construction were too slow. The silt and sands protruded beyond the advancing jetties, always in advance, the bar moving outwards until, weary of "chasing a rainbow," it was decided to build a lateral canal (Canal St. Louis), about 3½ mi. (5.6 km.) long to debouch into the Gulf of Foz.

The disappointment and its causes are shown, with sketches, in my "History of the Mississippi Jetties," published by John Wiley & Sons in 1880. The conditions and history were carefully examined by Captain Eads at the time of his visit to Europe in 1874 to learn the facts about many improved river mouths, to support his arguments for the bill then before Congress for improving the mouth of the Mississippi River by means of jetties. His opponents were using the history of the mouth of the Rhône as an argument in favor of the Fort St. Philip Canal from the Mississippi to Lake Borgne and against the jetty proposition. Now, the Canal St. Louis is to be practically abandoned and one 50 mi. (80.4 km.) long is to be built.

The tunnel is probably one of the most interesting rock tunnels ever undertaken in that it is, no doubt, the largest and one of the longest barge-canal tunnels in rock. The tunnel, lined throughout its nearly 4½ mi. (7.2 km.), is 22 m. (72.2 feet) wide inside the lining, and the crown of the arch (nearly semicircular) is 9.90 m. (32½ feet) high. The depth of water is to be 3 m. (10 feet). The plans illustrate the whole process of excavation, centering and lining, and are well worth the study of tunnel and canal engineers.

Briefly, as the detail plans are too extensive and numerous to be published entire, the process is as follows: A heading on the left at the base 3x3.25 m. (9.8x10.7 ft.), then one on the right at the same level and same size, then the enlargement of the two inward to give room for a track and ditch for drainage, then a small heading at the summit of the arch, then the enlargement upward of the two side headings to connect with the top heading, with a staging to receive the falling rock to be dropped into small dump-cars on the track, the permanent lining at the same time started on each side, then the enlargement of the excavation under the roof on both sides, which gives a chance to put in heavy centering on short posts, resting on the same mass core of unexcavated rock, then the masonry lining over the advancing centering completed, the centering then removed and carried forward and the bench removed.

The work is done by compressed air and it has the usual ventilating machinery and pipes, compressed-air pipes, drainage ditches, etc. The rock is quite varied in character: Dolomite of the Upper Jurassic, limestone, sequannian (above the Jurassic), and a mixture of the two. Suitable stone for the lining is found in the materials removed by the tunnel excavation. The contractor for the entire work is M. Chagnaud, who has recently completed the Loetschberg tunnel and approaches between Bern and the Simplon.



CROSS-SECTIONS OF ROCK TUNNEL ON MARSEILLES-RHONE CANAL, SHOWING SUCCESSIVE STEPS IN EXCAVATION AND LINING

At the time the sections were taken which are here reproduced (July 1, 1912), the tunnel had been completed and lined for a distance of 600 meters and the advance headings were driven 500 meters farther. It is perhaps needless to say that work upon the tunnel, as on practically all other constructive engineering works in the belligerent countries of Europe, is now suspended.

It is doubtful whether it will ever be resumed. The vast burden of debt due to the war will prevent the European nations from embarking on the construction of any public works not absolutely necessary for a long time to come.

Apart from this, however, the proposition to build this enormous and enormously costly tunnel, merely to save the dwindling traffic by river barges a few miles of navigation in the open Mediterranean, would appear to be a scheme absolutely quixotic from the economic point of view. Probably the tunnel will take its place with other abandoned engineering dreams.

MAP OF THE PROPOSED MARSEILLES-RHONE CANAL

Coast Erosion and Protection on Long Island and New Jersey--II

By Gerald O. Case*

SYNOPSIS—Takes up in detail the causes of coast erosion and illustrates the effects with general cases and specific references to the New Jersey coast. Theory and behavior of sand dunes.

Causes of Coast Erosion

A study of the causes of coast erosion is essential before it is possible to say what are the best means of combating it. Erosion is due to many causes, and coast protection works cannot be expected to be successful unless they are designed after a careful consideration of the causes of erosion at the particular place it is desired to protect. Many of the coast-protection works constructed on the New Jersey coast have proved a failure, and this has undoubtedly been due in a great measure to an imperfect knowledge of the causes of the erosion. The author has known of cases where the erosion was due to wind action in moving inland the natural sand embankments but where the protection works have been designed and constructed to prevent erosion by wave and current action. Of course, they were a failure and the erosion continued, which could have been certainly stopped by very inexpensive works had the correct cause of the erosion been recognized.

Subsidence of the Land

A new cycle of coastline changes are inaugurated by any important alteration in the relative levels of land and sea. Subsidence of the land or rise of the sea will, of course, cause erosion. Although there are evidences of local changes in the tide level on the New Jersey coast, there is no evidence of a gradual sinking of the land, as has been supposed by many people. Recent precise leveling in the vicinity of New York harbor confirms the surveys made in southern New Jersey, by proving an absence of any tilting of the land, and shows further that mean sea level is the same now as it was more than a quarter of a century ago at Sandy Hook.[2] The forces—wind waves, wind currents, tidal currents and wind action—now operating on the New Jersey and Long Island coasts are fully capable of causing the great changes which have undoubtedly taken place in recent years.

Inequalities in Amount of Littoral Drift

There is practically no such thing as static equilibrium of a foreshore, the surface layers being constantly in motion. When a shore is met with which is in apparent equilibrium, neither erosion nor accumulation taking place, it does not follow that movement is absent, but simply that removal and deposition approximately balance each other. Anything disturbing this balance at once becomes evident in a gain or loss to the foreshore. The effect of obstructions, such as a headland or a break in the continuity of the coastline, which will interfere with the littoral drift is therefore very important. Wherever an obstruction checks littoral drift, erosion very often takes place, under natural conditions, on the leeward shore.[3]

There are also peculiar conformations of the coastline which allow a certain part to be sheltered from particular winds, which are active in eroding material from other parts of the coast. In such a case littoral drift may commence at the particular point where the shelter, say, of a headland, ceases to be effective, thus producing severe erosion owing to the absence of drift from the other side to fill the place of the material removed.

The amount of littoral drift taking place on any part of the coast is dependent partly on the gradient of the foreshore and sea bed. With a very flat gradient the tendency is for the ends of oblique waves, on entering the shallow water, to be retarded and for the line of waves to swing round and come in at right angles to the coastline. The flatter the gradient, the less material will be moved by wave action per unit area. Erosion of the coast, under natural conditions, tends to flatten the gradient, and accretion to steepen it. If from any cause a shoaling of the sea bed takes place on any part of the coast, then the tendency will be for accretion to take place on the foreshore opposite the shoaling, and for erosion to take place on the leeward shore, due to interference with the alongshore supply of drift.

The general tendency is for the sea to erode headlands and projections. Reference to Fig. 3 will show that waves *G* which roll in parallel to the general coast line are oblique to the flanks of the headland and so tend to transport material from the point to the shore on either side—that is, from *C* to *B* and *C* to *D*. The action of oblique waves from either side also tends to move material away from the point of the headland. If the predominant waves causing littoral drift on the coast are coming from the direction *F*, most of the movement will be from *C* to *D*, but oblique waves *H* which may sometimes be formed will also cause a movement away from the point, in this case from *C* to *B*.

Given a straight coastline composed of alternate layers of hard and soft material, then the effect of the sea will be to form bays and headlands by erosion of the soft material; but after a time, perhaps several years, the projecting headlands would shelter the bays, and erosion of the soft and hard strata might then take place at the same rate. There is also a limitation to localized erosion due to other causes, and it is very important to bear this in mind. If from any cause, such as interference with littoral drift, erosion is caused along a certain length of coast, then if this continues a bay will be formed, the direction at which the waves strike the coast and also the gradient of the shore will be altered and the headland will shelter the bay. There are

*Consulting Engineer, Case Coast Protection Co., 1170 Broadway, New York City.

[2]Annual reports of the New Jersey State Geologist, 1912, 1913.

[3]The leeward side of a natural or artificial obstruction to littoral drift is the side sheltered from the wind waves causing the predominant drift, and the windward side, that exposed to the wind waves causing the drift.

therefore three things tending to stop the localized erosion and cause erosion to take place at the same rate all along the coast.

An outlying island has an important effect in interfering with littoral drift, causing accretion to take place between the island and the mainland and erosion to take place on the leeward shore. This action is seen by reference to Fig. 4. It is obvious that the coast from *B* to *C* is sheltered from the predominant oblique wave action; there is, therefore, a constant feeding in of material from *AB* and accumulation takes place between the island and the mainland. Material eroded from the sea face of the island also tends to accumulate in the form of spits built out toward the mainland. As little or no material will be moved on to the foreshore between *C* and *D* to make up for what is moved away from there by oblique wave action, erosion will take place. This effect may also be seen if a wreck is stranded near the shore. When the island has become joined to the mainland and a headland thus formed, the erosion of the sea face of the island will still continue, the material

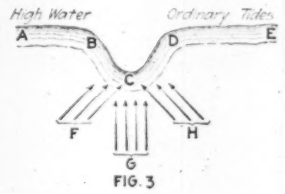


FIG. 3

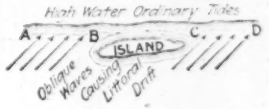


FIG. 4

FIG. 5

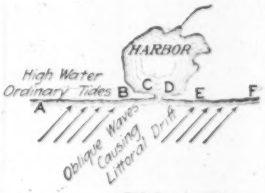


FIG. 6

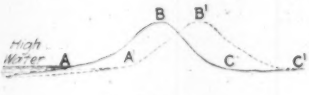


FIG. 7

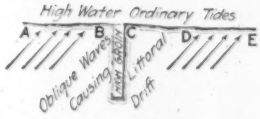


FIG. 8

FIGS. 3 TO 8. ACTION OF WAVES CAUSING DRIFT

from which will then be moved to the shore between *C* and *D*, causing the localized erosion there to stop and the coastline to be gradually straightened out again.

Thus there are some cases of localized erosion which may go on for some years, but which will inevitably be stopped in course of time by the operation of the laws of nature.

Erosion on the Leeward Side of Inlets

Where there is a predominant littoral drift, a large supply of material, and a river outlet cutting through the coastline, erosion as a rule takes place on the leeward side. When the drift encounters the mouth of the river or inlet it is trapped and carried into the inlet or out to sea. The flood tide, setting into the inlet with much greater velocity than on the open coast, carries in sand to form shoals and silt to form salt marshes, while the ebb current, on the contrary, tends to transport material out to the sea bed. Referring to Fig. 5 it will be seen that owing to the littoral drift being intercepted at *BC* little or no material may be moved to the leeward shore *CD* to replace that moved from there by oblique wave action.

If the amount of littoral drift traveling along *AB* toward the inlet is greater than the flood tide can move into the inlet or the ebb transport to seaward, as is often the case, then a spit is formed part of the way across the inlet, from *B* toward *C*, or in some cases is built right across and closes it up, when material can once more be transported to the shore between *C* and *D*, and the erosion there will then cease. All the time that the inlet exists part of the supply may be often cut off from the leeward shore *CD* and erosion often takes place.

The spit on the north side of Barnegat inlet has grown out in a southerly direction, and a very considerable amount of erosion at the same time took place at the south side of the inlet. A comparison of the surveys of 1840 and 1886[9] shows that between these dates the leeward shore at the south side was cut back for a distance of about 2300 ft., and the east shore eroded from 100 to 1000 ft. for a distance of $1\frac{1}{4}$ mi.

The coastline changes which have taken place at Hereford and Turtle Gut inlets also illustrate the general rule that when accretion takes place on the windward side of inlets, erosion takes place on the leeward side. Between 1842 and 1901 the shore at Anglesea (Five Mile Beach) on the leeward (south) side of Hereford inlet was considerably eroded—in places the high water line advancing 1500 ft., while considerable accretion took place on the windward (north) side. The same thing happened at Turtle Gut inlet between 1842 and 1901. Five Mile Beach on the windward side was built out in a southerly direction, and at Two Mile Beach on the leeward side extensive erosion took place at the same time.[9]

In places where the windward side of an inlet is being rapidly eroded owing to inequalities in the amount of littoral drift or other causes, then the tendency is for accretion to take place on the leeward side. This is partly due to the action of eddy currents depositing material in the form of shoals and partly to alterations in the conformation of the coast. Thus at Absecon, Great Egg and Corson Inlets rapid erosion has, in recent years, taken place at the north sides and some accretion at south sides of these inlets.

When a spit is formed in front of a harbor or inlet into which a river discharges, and, as frequently happens, it closes the inlet and in course of time a new entrance is opened by storms and floods on the windward side, we may then have a spit on both sides with the entrance at or near the middle (Fig. 6). By the action of littoral drift the windward spit *BC* will at once commence to grow and pushes the entrance gradually toward *D*. The extremity of the spit on the leeward side *D* will then be gradually eroded. This erosion may be partly due to the river cutting off the supply of littoral drift and partly to the action of the ebb currents concentrated on its end. If, as is often the case, the amount of accretion on the end of the windward spit is more than the

[9] Annual report of New Jersey State Geologist, 1885 and 1905.

amount of the erosion on the end of the leeward spit, then the spits will gradually unite again and close the inlet.

The northerly movement of Shark River spit has frequently closed up the inlet there, and when a new entrance has been formed further south by floods and gales, the entrance has immediately begun to move northward again; the spit on the southern side increasing in length by littoral drift, and the southern end of the spit on the north side being at the same time eroded. At Manasquan River the same thing has taken place.

Effect of Onshore Winds

Winds blowing directly onshore cause a denudation of the upper part of the beach to take place, and a consequent advance of the high-water line results. This is due to a surface current being formed in a landward direction, which is compensated for by an undertow seaward. At the same time the waves break further seaward and are also forced shoreward by the wind, having their frequency of impact increased. There is no time for the regular sequence of plunge, uprush and backwash to take place; the waves hurry in on top of one another, and a surf is formed. The character of the wave also alters from an oscillatory to a translatory at a considerable distance from the shore, thus aggravating the surface drift due to direct wind action, and consequently the undertow seaward. In this state the sand is churned up for some distance from the shore, and naturally the quantity in suspension is greatest near the bottom, where the undertow is at work transporting it seaward.

Direct Impact of Waves

The direct impact of waves is a potent factor in the disintegration and removal of cliff material, and its action can be observed during gales on any part of the New Jersey coast where there is a cliff or bluff exposed to wave attack. During gales at Avon the waves have sometimes struck the 10-ft. high cliff with sufficient force to cut it away for 50 ft. and send the spray 40 ft. high into the air.[10]

Large masses may also be torn off by the alternate compression and expansion of the air in crevices exposed to the wave stroke, or by the transmission of the blow of the waves to the sides of fissures and cavities which are filled with water. The destruction of cliffs is chiefly brought about by the undermining action of the waves aided by subaërial agencies—rain, frost, etc. The constant percolation of rain water through cracks tends to disintegrate the cliffs, and the action of frost is well known in pulverizing the surface and splitting off fragments. The continued erosion is, however, dependent on the waves and currents moving alongshore or seaward the material eroded by wave impact, and thus allowing the waves again directly to attack the cliff. If the undermining action is prevented by the accumulation of débris at the base, then the cliff will in time assume an inclination of repose, due to the action of subaërial agencies.

Formation and Movement of Sand Dunes

On the sandy coasts of New Jersey and Long Island, wherever there is a fairly wide expanse of sand dry at low tide, there is a tendency for sand dunes to form above high-water line of ordinary tides. At low tide a certain amount of sand is dried by the wind and sun, and as soon as it becomes dry the wind is able to transport it inland. Onshore winds are more effective in moving sand inland than the weaker and less frequent seaward winds in moving it back again seaward.

Above high tide the sand is arrested by stones, grasses, trees or other obstructions; the various grasses and shrubs which grow just landward of high water being very effective sand collectors, cause the formation of sand

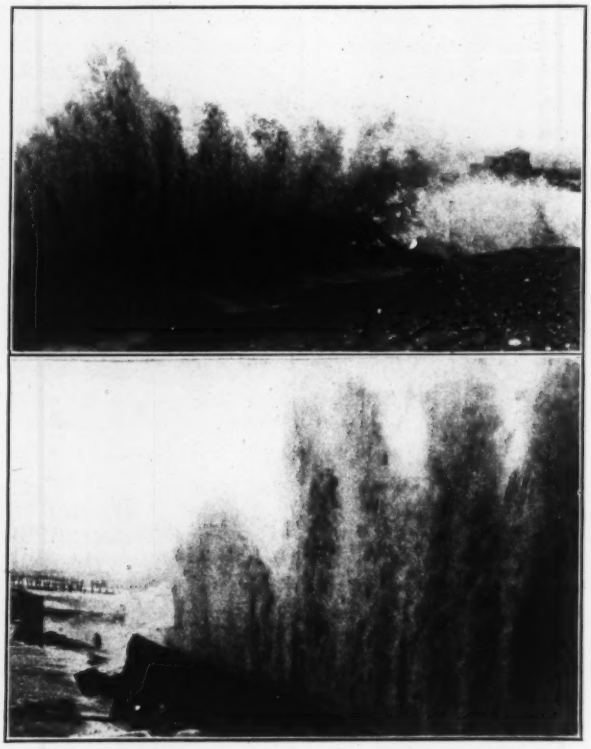


FIG. 9. HEAVY WAVES STRIKING AGAINST VERTICAL SEA WALLS

The views show clearly the inefficiency of vertical sea walls and their effect of shore erosion. During gales the waves hit the face of the wall and the falling water scours out material from the front of the wall, hastening its collapse

dunes. Dunes may also be formed by wind action alone; but on the coast margin the formation of irregularly shaped dunes is chiefly due to vegetable life and obstructions such as sea-formed sand embankments.

The shape of sand dunes (Fig. 7) when not interfered with is much the same as that of sand ripples. The windward (seaward) slope is usually from 4½ to 10 deg. with the horizontal, and the leeward (landward) slope any angle up to the angle of repose of sand. On the coasts of New Jersey and Long Island the dunes commonly vary in height from 10 to 40 ft.

Sand dunes, unless fixed either naturally or artificially by vegetation, move inland in much the same way as sand ripples. The velocity of inland travel is the rate of advance of the crest, which takes place by the accumulation of sand on the steep leeward slope *BC* (Fig. 7). The supply is brought by the wind in two ways—first, by rolling of coarse sand grains up the windward slope *AB* and over the crest *B*; and, second, by the deposit of part of the flying sand caught by the eddy on the

[10] "Transactions," American Society of Civil Engineers, Vol. 23.

leeward side and not tossed away again. Experience has shown that the rate of inland travel of unfixed dunes varies from 3 to 100 ft. per annum.

In places where the sand blown in from the foreshore is not replaced by sand brought by the sea, erosion of the foreshore naturally takes place; the inland movement of the sand dunes being followed by the inland movement of high-water line. Reference to Fig. 7 shows that when the crest has been moved from B to B' the high-water line will have moved from A to A'. While considerable attention has been given to the important effects of waves and currents in causing erosion, little attention has been paid to the also important effects of wind action in causing erosion of the New Jersey and Long Island coasts.

In some places sand dunes which became naturally clothed with vegetation, and were therefore fixed, have subsequently moved inland at a rapid rate owing to the destruction by man of the vegetation of the dunes. The advantage of vegetation for protecting sand dunes and preventing their inland movement was recognized in the United States in early days. On Dec. 16, 1758, an act was passed to prevent the destruction of the vegetation on the sand dunes. It prohibited farmers from turning cattle out to graze on the dunes of Long Island and other parts of the Atlantic Coast where they formed a natural protection against coast erosion. This act was renewed by state law in 1789.

Sand-dune embankments are also moved inland by wave action during gales and very high tides, material being moved by the waves up the windward slope and deposited on the leeward slope, thus causing a gradual inland movement of the sand ridge. Near Barnegat inlet and at other places, especially where the dunes are low, they are overflowed by the waves during gales.

All along the New Jersey coast evidence is to be found that sand-dune embankments and sand islands have moved inland a considerable distance. At Squan Beach, near Loveladies Island Life Saving Station, north of Beach Haven, Brigantine Beach, Peck's Beach and many other places salt marsh turf is found exposed on the foreshore at low tide, in which can be seen the imprints of cows' and horses' hoofs. The salt marsh was undoubtedly formed at the back of the sand dunes and under their shelter, and the dunes have moved inland and encroached on the salt marshes.

The rate at which the sand spits and sand islands move inland is difficult to determine with accuracy. In the "Annual Report of the New Jersey State Geologist for 1885" it is stated that "the lateral movement has in many cases amounted to more than the breadth of the beach since the settlement of the state, and is at present (1885) going on with undiminished activity." Captain Allgor stated that at Island Beach the westward movement had taken place at the rate of about 1.05 ft. per annum for the 40 years previous to 1885. When a sand spit is built up across a bay from the mainland on one side to the mainland on the other, then it will be moved inland at the same rate as the inland movement of the high-water line due to erosion of the mainland on either side.

In addition to causing coast erosion the inland movement of sand dunes in some places also causes the devastation of large areas of fertile land, and the dunes in their inland advance have buried houses, and even villages of considerable size. There are some places on the New Jersey coast where orchards have been buried within the lifetime of their owners and timbered lowlands have in several cases been overwhelmed and the timber destroyed by the encroaching sand.

Erosion Caused by Groins

Harbor piers and jetties projecting into deep water have practically the same effect as headlands and promontories in checking the littoral drift, and causing accumulation on the windward side and erosion on the leeward side.

Badly designed high groins constructed on the foreshore for coast-protection purposes in many cases stop littoral drift and cause a serious danger instead of a protection, owing to the great scour which takes place to the lee side of such structures. Fig. 8 shows a plan of a high groin erected across the foreshore. Material moved by oblique wave action is trapped on the corner at B. The shore material moved away from the leeward shore at DE is, therefore, not compensated for by littoral drift from the windward side of the groin and erosion must result. As material is scoured out from DE, material from CD moves into the hollow and erosion therefore takes place from C to E. After the high groin is full up on one side a water-falling action takes place. When waves roll obliquely up the shore on the windward side AB and the water falls over to leeward, stirring up material and scouring out the foreshore between C and D, and in course of time undermining the groin.

Erosion Caused by Sea Walls

Badly designed sea walls and bulkheads are also a very frequent cause of serious erosion. Waves striking the face of a vertical or nearly vertical wall project great volumes of water skyward, which, falling at the back of the wall, will scour out the backing, and falling at the toe will certainly dredge out the material in front of the foundations and cause the structure to collapse (Fig. 9). Even without the actual projection, the backwash of a wave from a curved smooth surface has a powerful scouring action.

Artificial Removal of Shore Material

The artificial removal of foreshore material for building and other purposes is also a cause of sea encroachment. If the foreshore is lying at its normal level, neither erosion nor accumulation going on, and material is removed from any part, an immediate result is to cause a gradient sloping to that part from all around it, and a consequent feeding in of material from the adjoining foreshore to fill the place of that which has been removed, so that the removal of material from a foreshore belonging to one person may prejudicially effect his neighbor's property.

Erosion of the coasts of New Jersey and Long Island cannot be traced to any one cause. There are, as has been pointed out, many forces and agencies at work on the coast line tending to cause erosion, and it is only by a close study of the conditions prevailing on any particular shore that engineers with experience in coast works can trace the cause or arrive at any conclusion as to the best means of coast protection.

Reinforced-Concrete Tower Tank at Middleborough, Mass.

By George A. Sampson*

SYNOPSIS—A 500,000-gal. tank, 41 ft. in diameter and 60 ft. high, supported on a cylindrical tower; total height, 165 ft. Tank has a hemispherical bottom. Details of design and specifications.

The application of reinforced concrete to standpipes and elevated tanks for the storage of water covers a period of only twelve years, during which time about thirty of particular note have been constructed. Some engineers consider its use purely experimental as yet and have grave doubts about the adaptability of concrete to such work, while a few unequivocally condemn its use in such structures of any considerable size. Further progress in transforming the field of experiment to one of recognized general practice can be accomplished only by a thorough discussion and study of the design, construction and success or failure of similar structures. With this end in view, an outline of the principal features of the design of the Middleborough tower tank is herewith presented.

Middleborough Water-Works

The supply is surface ground water collected in a large open well, aërated and filtered for the removal of iron and manganese, and pumped to a 230,000-gal. steel standpipe 20 ft. in diameter by 103 ft. in total height, situated in a residential portion of the town. The pressure is sufficient for domestic uses, but entirely inadequate for fire protection, which is now furnished by direct pumping. Under the present laws of Massachusetts, this requires the employment of six men at the pumping station, three of whom must be licensed engineers.

After careful inspections, in 1911 and 1913, it was recommended that the steel standpipe built in 1885 be discontinued as somewhat unsafe. After due consideration of the various features of the problem, it was decided to build a structure of adequate capacity and with the storage at a sufficient elevation to meet the demands of the combined domestic and fire service without resorting to direct pumping. The present population supplied with water is 5000, and the average daily consumption is 350,000 gal. Allowing for future growth, assuming that the pumps would be operated only by day and supposing that a large fire should occur in the early morning, demanding eight effective fire streams for two hours, the desired storage capacity was fixed at 500,000 gal.

The most available location for a new structure was on Barden Hill, about one mile southeast of the center of the town and 35 ft. above the present site. To furnish suitable fire-fighting facilities at the business center of the town, with due regard for the hydraulic factors involved, demanded that 386,000 gal. of this quantity be stored at a height of 121 ft. above the ground at Barden Hill, or 53 ft. higher than the top of the existing standpipe.

Types of Structure Considered

Four types of structure were considered: First, a steel standpipe about 40 ft. in diameter by 160 ft. high, which would have a total capacity of 1,500,000 gal.; without engineering this was estimated to cost $14,000; second, a concrete standpipe of the same general dimensions and capacity, at a cost of $39,000; third, a steel tank of 500,000 gal. supported on a steel tower about 110 ft. high, at $22,000; and fourth, a concrete tank of 500,000 gal. capacity, supported on a concrete tower and estimated at $24,000.

The first type was not further considered on account of its cost and large maintenance expense; nor was the second, because of its cost and the impracticability of constructing a satisfactory concrete structure subject to a 160-ft. head of water. The decision rested then between a steel and a concrete tower-tank. For comparison it was assumed, as an average period, that a steel structure would require two coats of paint inside and outside every five years, and if so treated would have a life of thirty years. The annual cost of painting would amount to $340. Also direct pumping into the mains for several days during the time of painting would be necessary. This should be avoided if possible, especially in view of the growth of the town. For preserving the quality of the water, maintaining it at a more uniform and desirable temperature and adorning the landscape, the concrete tank was preferable. In first cost, the steel tank was about $2000 less, and possessed the advantage of being a common type of structure.

With the foregoing and other considerations in mind, the one question to be decided was: Can a concrete tank be constructed that shall remain sufficiently watertight at all times to prevent unsightly discoloration and disintegration from seepage and leakage, combined with freezing temperatures? The method of supporting the tank on a concrete tower was of secondary importance and was considered capable of a reasonable solution. After an exhaustive study of existing concrete standpipes and tower tanks, together with the apparent causes contributing to their good and bad features, it seemed a conservative conclusion that a reinforced-concrete tower tank of 500,000 gal. capacity could be built so as to warrant its use.

Design of the Tank

In the design the question of the foundation was the first to be considered. The soil upon which the footing will rest is extremely fine, well-compacted sand, overlaid for about one-quarter of the area with a thin bed of gravel. The safe bearing power of this fine material was determined experimentally by loading a timber set at the elevation of the bottom of the footing. At a loading of from 1 to 3½ tons per sq.ft., the settlement was uniform and slight, being only $\frac{1}{32}$ in. for each additional ½ ton; but 4 tons per sq.ft. produced a relatively large

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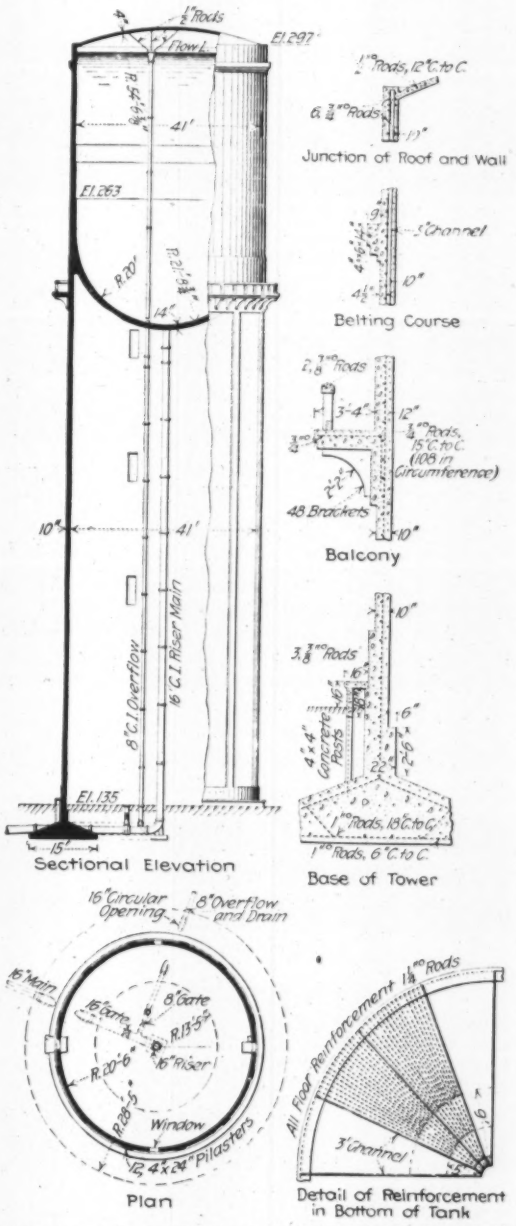
settlement—$3\frac{5}{2}$ in. for the last ½ ton. The maximum loading was therefore fixed at $3\frac{1}{2}$ tons per sq.ft. The total dead-weight on the foundation soil is 4485 tons, or 2.28 tons per sq.ft. The wind load was determined from an assumed velocity of 70 mi. per hr., producing a wind pressure of 30 lb. per sq.ft. on the horizontal projection of the cylinder, thereby adding 0.68 tons per sq.ft. with a full tank, and producing a total maximum pressure of 2.96 tons. Although the wind pressure is slightly



DETAILS OF DESIGN OF THE MIDDLEBOROUGH REINFORCED-CONCRETE TOWER TANK

more than doubled with an empty tank, it is more than offset by the reduction in the dead-weight of the water, so that the maximum mentioned represents the worst condition.

A cylindrical tower was adopted in preference to a number of columns, because with it a more ready and definite computation of stresses was possible; while it could be made to present a more pleasing appearance, was better adapted to the contours at the site, and seemed more economical to construct. The plain aspect of a simple cylinder was relieved by the addition of twelve 4x24-in. pilasters which were also assumed to take their proportion of the load. The appearance of solidity at the base is accomplished by the use of a concrete seat supported on the foundation to prevent settlement. The compression at the bottom of the 10-in. tower wall resulting from the dead load is 483 lb. per sq.in., which is increased to a maximum of 631 lb. by a wind of 70 mi. per hr.

Details of the Tank Proper

The tank proper is 41 ft. in inside diameter and 64 ft. deep from under side of the dome (El. 300) to the inside of the hemispherical bottom (El. 236), the dome having a rise of 4 ft. and the bottom a depth of 20 ft. The straight walls of this tank vary in thickness from 10 to 16 in. and are reinforced to care for increasing pressure toward the bottom. The bottom varies in thickness from 14 in. at the lowest part to 18 in. at the connection to the tank walls. Its reinforcement is given in the detail in the accompanying figure.

By far the most important part of the structure and the most difficult to design and construct is the tank proper. The writer wishes to emphasize the use of a hemispherical bottom, which should prove superior to the flat beam and slab construction commonly employed for small elevated tanks, and to the dome bottom used in a few instances for tanks of considerable size. The advantages of the hemispherical over the dome design lie in a 17-per cent. increase in capacity for the same height of vertical wall, or a 34-per cent. decrease in the height of wall for the same capacity; a practically self-cleaning bottom; a better distribution of stresses because the enormous thrust in the dome bottom, which is concentrated at the bottom of the tank, the most critical point, is replaced by a uniform tensile stress coincident with and analogous to the tension in the tank wall. The only other stress at the junction between wall and bottom is a vertical downward load which is easily calculated and cared for. The reduction in height of vertical wall is of prime importance in reducing the chances of leakage. The hemispherical bottom will be poured continuously to make a monolithic bowl up to the point where it becomes a part of the supporting tower. The cost of storage should be no greater than for the dome bottom.

The thickness of concrete at and near the bottom of the wall of the tank and in the hemispherical portion is such that without any assistance from the steel reinforcement its stress in tension is about 250 lb. per sq.in. The tensile stress in the steel, acting independently, would be approximately 14,000 lb. per sq.in.; and with both materials acting in conjunction, the computed tension in the concrete is 215 lb. and in the steel 2150 lb.

The tank is covered to guard against the growth of algæ not uncommon in filtered water exposed to the light, and to prevent freezing. The roof is a dome with its thrust carried by steel reinforcement embedded in the top of the tank wall.

The connection between tank and water main is through a 16-in. flanged riser pipe fitted with an expansion joint. An 8-in. flanged overflow, also with an expansion joint, discharges at a safe distance from the foundation.

The essential qualities of the cement required is fineness of grinding, strength and a slow initial set. The sand, in addition to the usual requirements, shall show a tensile strength equal to standard Ottawa sand, and for the tank it may be necessary to mix sands from two or more sources to obtain the proper gradation of sizes. The coarse aggregate for the tank is gravel varying in diameter from ¼ in. to 1¼ in., and, if necessary, screened into various sizes and combined in the proportion deemed expedient to secure maximum density. Either gravel or broken stone may be used for the other parts of the structure.

The steel reinforcement is hard grade round rods, plain or deformed, and conforms to the specifications for concrete reinforcement bars adopted by the Association of American Steel Manufacturers in 1910, and revised in 1912. The laps are at least 40 diameters, and in addition thereto each joint in the tank is secured by two "Crosby" wire clips, or their equal. Vertical channels are employed to support the horizontal reinforcement of the tank, drilled to the exact spacing of the rods and provided with suitable means for rigidly holding them.

The proportions of concrete for the foundation are 1:2.5:5; for the tower, 1:2:4; for the hemispherical bottom and wall of the tank to El. 279, 1:1:2; from El. 279 to 293, 1:1.5:3, and above El. 293, including the roof, 1:2:4. The relative amounts of sand and stone may be varied, the percentage of cement to the sum of the aggregate to remain as stated.

Details of the Construction

The concrete must be mixed thoroughly and by an approved machine. Care must be taken in placing to prevent the separation of the ingredients, and for the wall of the tank concreting will be carried on each successive day. No special waterproofing ingredient is required, nor is a metal dam being used at the junction between days' work. All laitance is to be removed from the surface at the end of the day's work before the initial set occurs. The old surface is to be cleaned with a wire brush and, immediately before placing new concrete, coated with a neat cement grout and a layer of mortar. It is hoped that it will not be necessary to resort to any waterproofing lining or coating on the interior.

Steel forms designed and made by the Blaw Steel Construction Co. are being used for the outside surface of the tower and tank. The height of each ring is 4 ft.; and at least two complete rings are required to insure the placing of concrete on successive days. No permanent bolts, wires or other ties that would be cast in the concrete are being used to secure either the steel or wooden forms.

The steel forms are producing a smooth, uniform surface which will require very little finishing. The exposed base of the tower below El. 139 will be rubbed to such surface with a carborundum block and water.

The following clause in regard to water-tightness may be of interest:

> The concrete in the bottom and wall of the tank shall be substantially water-tight at all times. Any leakage amounting to jets or visible seepage shall be repaired by and at the expense of the contractor and by methods approved by the engineer. Small damp spots, if few in number, which do not increase, nor disfigure the appearance of the concrete, will be considered to meet the requirements hereunder. It is intended that the work shall be sufficiently waterproof that severe freezing will not at any future time threaten the integrity of the concrete, and that the general appearance of the structure will not suffer through efflorescence or other disfiguring stains.

The contract for the work has been awarded to the Hennebique Construction Co., of New York, for $23,140, and the structure is now under construction. Alvin C. Howes is chairman of the Water Commissioners and Thomas F. Dorsey is Resident Engineer for the writer, who is responsible for the design and construction.

Provo Reservoir Company's Irrigation Project

By Clarence S. Jarvis*

The Provo Reservoir Co. was organized in 1908 to construct a high-line canal 40 mi. long from Provo River, capable of supplying water to some of the most desirable lands in Utah and Salt Lake valleys.

Beside filings for 150 sec.-ft. of the surplus water in Provo River, which is ordinarily available until after

FIG. 1. TRIAL LAKE, UNION RESERVOIR CO.

Used jointly by a number of irrigation companies. View taken from top of dam. Note the ice sheet in the distance

the middle of June, appropriations were made for storing flood water in more than thirty lakes and meadows near the head of Provo River. Other irrigation companies are jointly interested in the larger reservoirs (through the Union Reservoir Co.), the maximum area of a single storage basin being about 140 acres for a 40-ft. depth of

FIG. 2. A 30-FT. RESERVOIR OUTLET CUT

storage. The lake basins (Fig. 1 is an example) appear to be pockets formed by glacial action. Outlet cuts (Fig. 2) through the terminal or lateral moraine that forms the rim of each basin provide means of drawing the lake surface down to the desired depth. Short rock-fill dams

*Chief Engineer, Provo Reservoir Co., Provo, Utah.

(Fig. 3) inclosing a core of puddled clay, mountain soil and rock waste are built where necessary.

These reservoir sites are situated at El. 9500 to 10,500 above sea level. Due to the remoteness from inhabited districts, the high altitude, the consequent inclement weather and short seasons for construction, and the rocky and rugged character of this locality, construction has proceeded more slowly than was expected; but the reservoirs already built have demonstrated the value of this storage system and its efficiency. The water when released from the reservoirs flows down the natural channel of the Provo River a distance of about 60 mi. to the intake of the Provo Reservoir Co.'s canal; and with the 40 mi. of canal the delivery will be through 100 mi. of waterway.

The canal takes out of Provo River about 1 mi. above Olmstead in Provo Cañon. Thence it proceeds through a 6x7-ft. tunnel for 1000 ft. through solid limestone; thence through 2100 ft. of No. 144 Maginnis steel flume, a 200-ft. section of which has recently been replaced by a 6-ft. corrugated ingot-iron pipe over a mud slide; thence through a 260-ft. rock tunnel; thence 2600 ft. in a 60-in. redwood

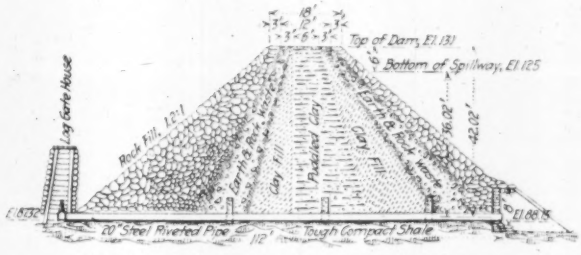


FIG. 3. EARTH AND ROCK-FILL DAM

The 20-in. steel outlet pipe was made from ¼-in. plates. The sections were 20 ft. long, joined by ⅝x2½-in. steel angle flanges and lead gaskets

stave pipe used as an inverted siphon for crossing Provo River, and delivering on Provo Bench.

To cross Dry Creek, north of Lehi, the water is delivered through 1000 ft. of wood-stave pipe of 49-in. diameter, with a maximum pressure head of 80 ft. on the inverted siphon.

At Jordan Narrows a riveted steel pipe, 1458 ft. long, 40 in. in diameter, has been constructed out of ¼-in. and $\frac{5}{16}$-in. steel plate. The approach to this pipe is a reinforced-concrete conduit 1700 ft. in length and approximately 48 in. in diameter. The maximum pressure head that the steel pipe may have to withstand is 270 ft.

The gradient used in tunnels, flume and pipe lines ranges from 0.002 to 0.004; and in the canal from 0.0005 to 0.002, dependent upon the required cross-section and the type of soil encountered.

The canal system has delivered in excess of 100 sec.-ft. of water satisfactorily to the lands from Provo Bench to the Bull River Canal north of Lehi Junction. It is intended ultimately to deliver in excess of 170 sec.-ft. through this canal system, about half of it to be carried into the West Jordan district, in Salt Lake County.

The lands to be directly benefited are about 8000 acres in Utah County, and the same area in Salt Lake County. As these tracts include some of the most fruitful and desirable lands in this district, well situated for markets and along railroad lines, the project has decided advantages. However, it might be well to point out some of the chief difficulties, which are as follows:

1. The actual cost of storing water in such reservoir basins as are included in this reservoir system ranges from $6 to $20 per acre-foot.

2. The patrolling of stored water from the head of the river for a distance of 60 mi., passing numerous headgates and dams in the lower valleys that have been accustomed to diverting the entire flow of the river during the low-water season, has been rendered more difficult through lack of definite data on loss in transit, the varying flow of the river, the primitive measuring devices and the crude regulating structures in use in some of the canals; and from an innate prejudice felt by owners of old water rights against the new applicants that cause a change in the regulations of the river.

3. Acquiring right-of-way for more than 10 mi. across improved farm and city property, through orchards, between houses and barns, where the right-of-way far exceeded the cost of construction, and where numerous bridge, culvert and flume structures were necessary along the canal line.

4. The definition of the term "surplus water." Some authorities hold that all water in a river that is not being applied to beneficial and economical use is surplus and subject to appropriation, even though a careless or wasteful use of water might consume the entire flow of the stream. Upon this definition depends in large measure the success or failure of a new irrigation project. Efforts are being made to reach a compromise agreement, providing that when all old rights are satisfied on a basis of 50 or 60 acres per second-foot of water, then all of the surplus above this amount belongs to the Provo Reservoir Co. until its acreage is supplied on a basis of 70 acres per second-foot; after which all further surplus shall be divided pro rata according to the acreage and the needs of the various classes of soil.

Throughout the construction of this project Joseph R. Murdock has been president and manager of the company; C. S. Jarvis has been Chief Engineer, and E. D. Clyde has been Superintendent of Construction on the reservoirs. I. H. Jacob is Resident Engineer, and has had charge of water distribution since 1912.

The Production of Radium on a manufacturing basis by the U. S. Bureau of Mines from Colorado carnotite ore has recently been announced by F. K. Lane, Secretary of the Interior. The Bureau has been studying the production of radium with a view to decreasing the cost. The figure reached is $36,050 per gram of radium bromide and this includes the cost of ore, the insurance, repairs and depreciation on plant, the development cost of the process and all expenses. Radium bromide has been selling for $120,000 to $160,000 per gram. This reduction in cost does not mean an immedate drop in selling price, since the carnotite claims are closely held. Ten claims are being operated at Long Park, Colo., by the National Radium Institute, with which the bureau has been coöperating. A concentrating plant for low-grade ores has been erected by the Institute. Grinding and sampling machinery and an extraction plant have been set up in Denver, the present capacity being for three tons of ore per day. The average recovery has been 85 per cent., and with the last five carloads of ore it has been 90 per cent.

United States Public Lands unappropriated and unreserved amounted on July 1, 1915, to 279,000,000 acres. Of this area 173,000,000 acres has been surveyed and 106,000,000 acres is unsurveyed. These public lands belonging to the Federal Government are in 25 states. The bulk of the land, however, is in the 10 arid states. Nevada heads the list with 55,000,000 acres, and then follow in the order named Arizona, Utah, Wyoming, New Mexico, California, Montana, Colorado, Idaho and Oregon. Oregon's public lands amount to 15,442,000 acres. South Dakota has nearly 3,000,000 acres, and Washington a little over 1,000,000 acres. In most of the other states where public lands are located the amount is comparatively small.